HOUSE OF LORDS

SESSION 1999–2000
1st REPORT

SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

NON-FOOD CROPS

REPORT

Ordered to be printed 25 November 1999

LONDON: THE STATIONERY OFFICE
£8·60

HL Paper 5

WELLCOME
LIBRARY
General Collections
P
6286

22501151213

HOUSE OF LORDS

SESSION 1999–2000
1st REPORT

SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

NON-FOOD CROPS

REPORT

WELLCOME TRUST INFORMATION SERVICE
19 JAN 2000
ACC. No. 16268
CLASS: NA HouL

Ordered to be printed 25 November 1999

LONDON: THE STATIONERY OFFICE
£8·60

HL Paper 5

CONTENTS

Page
SUMMARY 5

CHAPTER 1: INTRODUCTION 7
- STRUCTURE OF INQUIRY 7

CHAPTER 2: BACKGROUND 9
- COMMISSION REPORT TO COUNCIL JANUARY 1990 11
- SELECT COMMITTEE REPORT FEBRUARY 1991 12
- POST REPORT *ALTERNATIVES IN AGRICULTURE* JANUARY 1995 12
- POSTNOTE 125 12
- *ACTIN* 13
- *FORESIGHT* 13

CHAPTER 3: POSSIBLE APPLICATIONS AND BENEFITS 14
- ENERGY CROPS 14
  - *Biomass for electricity generation* 14
  - *Bioethanol* 15
  - *Biodiesel production* 15
- INDUSTRIAL MATERIALS 16
  - *Oils* 16
  - *Starches* 16
  - *Fibres* 17
- SPECIALITY CHEMICALS 17
  - *The "Roofless Factory"* 18

CHAPTER 4: AGRICULTURAL SUPPORT PROGRAMMES 20
- CURRENT SUPPORT MEASURES FOR FOOD CROPS 20
- CURRENT SUPPORT MEASURES FOR NON-FOOD CROPS 21
- AGENDA 2000 21

CHAPTER 5: ECONOMIC PROSPECTS FOR GROWING NON-FOOD CROPS 22
  - *Short Rotation Coppice* 22
  - *Fibre Crops* 23
  - *Oilseeds for Industrial Purposes* 23
  - *Evidence of Demand* 24
- CONCLUSION 25

CHAPTER 6: PUBLIC POLICY OBJECTIVES 26
- ENVIRONMENT POLICIES 26
- INNOVATION POLICIES 28
- LIFE-CYCLE ASSESSMENT 28

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS 29
- MINISTERIAL RESPONSIBILITIES 29
- INNOVATIVE POTENTIAL 31
- NON-FOOD CROPS AND THE CAP 31
- ENERGY AND ENVIRONMENTAL ISSUES 32
- REGULATORY RESTRAINTS AND DRIVERS 32

APPENDIX 1—Membership of Sub-Committee I; Declaration of Interests 34
APPENDIX 2—List of Witnesses 35
APPENDIX 3—Reports on Visits 36
APPENDIX 4—Glossary 44

References to evidence

The written and oral evidence received by the Committee is published separately including a copy of the Call for Evidence (issued February 1999) (HL Paper 5–I). Pages of the Report are numbered in bold type, pages of evidence are numbered in ordinary type. References in the text of the Report are as follows:-

Q refers to a question in oral evidence;

p refers to a page of written evidence.

FIRST REPORT

25 November 1999

By the Select Committee appointed to consider Science and Technology

ORDERED TO REPORT

NON-FOOD CROPS

SUMMARY

Most of the agricultural land of the United Kingdom is devoted to food production, through crop cultivation or grazing for livestock. A small but significant proportion, however, is used for the cultivation of crops used by other industries. Although some of these "non-food crops" – for example, hemp and flax – have a history as long as cereal production, others are quite novel or are being grown for novel purposes ranging from energy generation to the manufacture of pharmaceutical products. Exciting possibilities include, for example, the development of plant-derived vaccines, and speciality chemicals for industrial use that may be prohibitively difficult and expensive to synthesise. Indeed, the opportunities offered by advances in plant biochemistry to generate renewable materials that could replace products synthesised from mineral oil are almost limitless.

The combination of pressures on the food production sector and scientific advances is causing increasing attention to be directed towards the potential of the non-food sector. However, our inquiry found that the development of new industries is inhibited by a number of factors. The system of financial support for crop cultivation – under the Common Agricultural Policy – is directed towards food production. While some non-food crops do enjoy a significant degree of support under the CAP, this is largely as a by-product of the cereals regime and is not therefore well-focused on the development of new industries. When we began our inquiry, it seemed possible that major reform of the CAP was finally under way. In the event, major reform has been put back to the middle of the next decade, but we consider it essential that the Government should use the period before further reform to evaluate the potential for the growth of new non-food industries, and the appropriate regime for them.

The second problem we identified is that these industries fall between several Whitehall stools. The Ministry of Agriculture, Fisheries and Food is not of course responsible for energy policy, or for environmental policies, or for industrial innovation. There is a grave danger that research and development may be concentrated on crops which may appear to have significant potential in terms of land use, but whose output has no clear place in the priorities of other departments. At the same time, there is an equal and opposite danger that other departments may maintain regulatory regimes or policy strategies that inhibit the development of viable industries. We are, for example, concerned at the excessive regulation surrounding the growth of industrial hemp, and believe that the hierarchy of objectives for waste management gives too little encouragement to the development of biodegradable packaging from non-food crops.

In order to achieve more co-ordinated thinking about the potential for these industries we conclude that it is imperative that they should have a ministerial "champion" in the shape of the Minister for Science. Britain has a leading position in the field of research for pharmaceutical and other products, and we believe it is important that this should be maintained.

We believe it should be the responsibility of the Minister for Science to chair an inter-departmental committee, supported by the Office of Science and Technology. This should involve all interested departments, to ensure not merely that their policies are compatible but that they are focused

on the potential of these crops to form the basis of new industries. We hope that this modest proposal for improvement in the policy framework will not fall foul of departmental inertia.

A third and parallel problem we identified is a similar need for more co-ordination of policy at the level of the European Commission, and we urge the Government to press for a more coherent European approach, with emphasis on the support of a co-ordinated research programme. We are particularly concerned that this should be concentrated not merely on the development of new crops, but on the handling and processing techniques essential to their industrial exploitation.

The fourth set of issues we identified relate to the environmental impact of these crops. Their development offers important environmental benefits, enabling natural, renewable and biodegradable materials to be substituted for synthetic materials whose production involves substantial use of non-renewable resources, and whose disposal may be difficult and costly. On the other hand, some developments depend on techniques such as genetic modification which themselves raise serious environmental concerns. Detailed research and careful analysis of the environmental costs and benefits of these novel crops is essential. This is a further important reason why there is a need for "joined-up thinking" in this area, with the Minister for Science accepting responsibility to lead an informed debate.

CHAPTER 1: INTRODUCTION

1.1 At the start of our inquiry in February, the Agenda 2000 proposals for further reform of the Common Agricultural Policy (CAP) seemed likely to make significant changes to market support for some of the main agricultural products grown in the European Union (EU). We were concerned as to whether these changes would have particular consequences for non-food crops. Would they inhibit innovations in science and technology, which might lead to the introduction of new industrial products or to environmental improvements by the substitution of renewable for non-renewable resources?

1.2 Non-food crops considered in this report include all agricultural crop products that could be used by industries other than the food industry, with the exception of timber, tobacco and horticultural products. We have considered only crops grown deliberately for industrial use; we have not considered industrial use of agricultural waste[1].

1.3 An objective of the original Agenda 2000 proposals was to cut market support so that the gap between EU internal prices and world prices would be reduced, providing both food and non-food industries with more competitive raw materials. Direct income support for arable crops would be given as non-crop-specific area payments, the compulsory set aside rate[2] would be fixed at 0 per cent, and no new crops would be eligible for subsidy. As a significant proportion of non-food crops are planted on set aside land and farmers are unlikely to introduce new crops unless returns at least match those for existing crops, the impact of these proposals on non-food crop production in the EU could have been significant.

1.4 But the potential difficulty for non-food crop growers from the CAP reforms was not our sole concern, however significant those reforms might be. Our interest also lay in the implications of EU and national policy for advances in biology, biotechnology and technological developments more generally. Are these advances, which might allow processes currently undertaken by conventional chemistry[3] to be achieved by cultivation and/or genetic modification of plants, being impeded by regulation and by a failure to recognise the contribution that such products can make to the achievement of policy objectives? We were especially interested in the implications for the use of plant products as fuel or in sustainable and biodegradable products, and in new applications of plant-based material.

1.5 In March 1999, after a long period of negotiation, agreement on the Agenda 2000 proposals was finally reached at the European Council in Berlin. These represented a considerably less radical reform than had been envisaged. In particular, cuts in support prices were more modest and it was agreed that the default rate of compulsory set aside would be set at 10 per cent until 2006. But this amounted to a delay rather than a reversal of the pressures that had triggered our inquiry. The focus of our inquiry therefore shifted to the question of the best use of this breathing space. Would it allow time for the evolution and testing of new technologies that could, in the long term, prove economic and advantageous to the United Kingdom? Or would the perpetuation of subsidies, driven by an outdated and time-limited food policy, stifle innovation and inhibit the development of new technologies?

STRUCTURE OF INQUIRY

1.6 The emphasis of much recent work on non-food crops has been to consider alternative uses for agricultural products. We have looked at the other side of the same coin, the technological opportunities presented to industry by non-food crops. This has meant that our focus has been different from that of previous reports. We have examined the potential of crops to produce materials that could lead to new industries or to innovative ways of meeting existing demands. We have not examined alternative uses of land, for example for amenity purposes or housing. Although these may represent significant opportunities for diversification for farmers, they are different from the innovative processes for industry we wished to examine.

1.7 This inquiry was conducted by Sub-Committee I (see Appendix 1). They issued a call for evidence in February 1999 inviting submissions on the general economic potential of these crops and their role as replacements for less renewable resources. We asked in particular for evidence on environmental and ecological implications and for the role of Life-Cycle Assessment. In our call for evidence, and at almost every oral hearing, a question was asked about disincentives or regulatory barriers to the development of non-food crops.

---

[1] Though the use of forest waste for energy generation is mentioned.

[2] The proportion of arable land which a farmer must set aside to qualify for arable area payments.

[3] By taking small molecules and synthesising more complex ones for producing specific products.

1.8 Written evidence was received from forty-seven organisations or individuals and oral evidence was taken at ten meetings. We would like to thank the many individuals and organisations who responded to the call for evidence, and those who presented oral evidence; they are listed in Appendix 2. We are most grateful to them for their time and effort. We also wish to express our thanks to those whom we visited, in particular those involved with Project ARBRE, the MAFF Central Science Laboratory, the Biology Department of the University of York, and Croda Universal Limited in Hull (notes of these visits are in Appendix 3). We would like to thank them all for their time, their hospitality and their patience with us over the many changes in arrangements that had to be made. We would also like to thank the staff of the United Kingdom Permanent Representation in Brussels and staff of the European Commission for their assistance during our visit to Brussels. Particular thanks go to our Specialist Adviser John Slater, former Chief Economist, MAFF, whose experience and expertise with agricultural support programmes has been invaluable.

CHAPTER 2: BACKGROUND

2.1 Soils and climate in the United Kingdom are suitable for growing a wide range of non-food crops. Until the 20th century, plants were an important source of raw materials for household and industry use in the United Kingdom; vegetable oils were used for making soap and as lamp oil and lubricants, flax was grown for textiles, hemp was used for making ropes and sacking, and short rotation coppice was used for charcoal. Agricultural products also provided cereals and hay for horses, which were the major source of locomotive power both within agriculture and more widely.

2.2 However, since those times, there have been many changes. Traditional uses of non-food crops have been largely replaced by products based on fossil fuels. Nevertheless there are diverse possible uses for plant products outside traditional food markets. A list of applications of non-food crops and the plant varieties that contain suitable materials is given in Box 1.

Box 1
Examples of non-food crops, classified by end-use

AGROCHEMICALS:	Spurge, pyrethrum, annual wormwood, caraway, quinoa
BOARD, COMPOSITES, BUILDING AND INSULATION MATERIALS:	Hemp, flax, kenaf, cotton, common reed, miscanthus, sunflower
CORDAGE AND SACKING:	Hemp, kenaf, nettle
COSMETICS AND TOILETRIES:	Amaranth, caraway, linseed, evening primrose, jojoba, pot marigold, coriander, bugloss
DYES:	Woad, madder, safflower
ENERGY AND FUELS:	Oilseed rape (OSR), sunflower, willow, miscanthus (elephant grass), poplar, reeds, spurge, cordgrasses
INDUSTRIAL RAW MATERIALS:	OSR, sunflower, castor, chicory, crambe, kenaf
LUBRICANTS AND WAXES:	OSR, linseed, spurge, rain daisy, honesty, meadowfoam
PAINTS, COATINGS AND VARNISHES:	Pot marigold, rain daisy, stokes aster, hemp
PAPER AND PULP:	Hemp, flax, kenaf, miscanthus
PHARMACEUTICAL PRODUCTS AND NUTRITIONAL SUPPLEMENTS:	Amaranth, caraway, borage, honesty, hemp, meadowfoam, linseed, evening primrose, mallows, field scabious
PLASTICS AND POLYMERS:	Honesty, castor, meadowfoam
RESINS AND ADHESIVES:	Rain daisy, stokes aster
SOAPS, DETERGENTS, SURFACTANTS, SOLVENTS AND EMULSIFIERS:	Coriander, hemp, spurge, cuphea, poppy, gold of pleasure, castor, quinoa
TEXTILES:	Hemp, flax, nettle

Source: *Crops for Industry and Energy in Europe* (European Commission 1997).

2.3 The relative importance of potential markets for non-food crops is indicated in Box 2.

Box 2

Potential Markets for Non-Food Crops

High Value / Low Volume

Pharmaceuticals, fragrances

Fibres for fibre composites
Oils for speciality chemical feedstocks
Oils for lubricants
Fibres for high quality papers
Fibres for industrial textiles and geotextiles

Oils for bulk chemical feedstocks
Starches for bulk chemical feedstocks
Biodiesel (from oilseed rape)
Biomass energy crops

Low Value / High Volume

Adapted from *Alternatives in Agriculture* (POST 1995)

2.4 The emphasis of the CAP has been on support for food rather than non-food crops. Certain non-food crops, notably linseed, have also been encouraged under the regime. The non-food crops grown in the United Kingdom that use significant areas of land are oilseeds, such as linseed and high erucic acid oilseed rape, fibres such as hemp and fibre flax, and energy crops such as short rotation coppice (SRC) (Box 3). Of these, hemp and flax fibre depend on a specific support regime and, apart from linseed, most of the other crops are grown only on set aside land. Some food crops, such as cereals and potatoes, provide raw materials (starch) for non-food purposes but information is not available on the precise areas grown for this purpose. The total area devoted to non-food crops in the United Kingdom is thought to be less than 5 per cent of the total area of arable land (6.3 million hectares), although it may be rising.

Box 3

Areas of Non-Food Crops in the United Kingdom, 1998

	Hectares
Linseed	101,000
Oilseeds (on set aside land) for industrial use	30,000
Fibre flax and hemp	19,000
Short rotation coppice	500

Source: MAFF, SOAFED, DANI, WO, *Agriculture in the United Kingdom 1998,* Table 2.2 (TSO 1999)

2.5 Similarly, non-food crops currently make only a modest contribution to the total value of agricultural output. Because of the competition from alternative raw materials and from imports, the value of the main non-food crops is rarely higher than that of food crops. Some non-food crops supplying raw materials for niche markets, such as cosmetics and healthcare, are of high value and profitable to the farmer and processor, but the areas are not currently large. It is almost certain that the current value of the non-food crop sector does not reflect the economic contribution, or the potential scientific and environmental contribution, which these crops could make.

2.6 But there are now signs of a resurgence of interest and indications that non-food crops could provide the basis for new industries. Certainly, there is adequate agricultural land, with arable land accounting for one-third of the total agricultural area (Box 4). With the continuing decline of the agricultural sector[4], non-food crops could provide welcome opportunities for diversification and increased economic activity in rural areas.

Box 4

Agricultural Land Use in the United Kingdom, 1998

	000 hectares	Percentage of total
Total agricultural area	18,593	100
Grass and rough grazing	11,194	60
Total arable	6,308	34
Of which		
Cereals	3,420	18
Oilseeds (mainly for food use)	605	3
Set aside	314	2
Other	777	4

Source: MAFF, SOAFED, DANI, WO, *Agriculture in the United Kingdom, 1998,* Table 2.1 (TSO, 1999)

2.7 In 1990, the European Commission issued a report on non-food crops, and the Select Committee on the European Communities of this House reported on non-food uses of agricultural products in 1991. The Parliamentary Office of Science and Technology (POST) produced a report *Alternatives in Agriculture* in 1995[5] and updated this with POST Note 125 in 1999. These reports have been essential starting points for our inquiry and in the rest of this chapter we comment on aspects of these as well as some recent developments.

COMMISSION REPORT TO COUNCIL, JANUARY 1990

2.8 The European Commission, in a report to the Council of Ministers in January 1990[6] on the use of agricultural commodities in the non-food sector, noted that "the structural imbalances between the supply and demand for agricultural products and the intense competition which this provokes in the Community and world markets, justify an important effort in this area". The Commission's report examined the scope for developing agricultural structure policy in a such a way as to encourage farmers' participation in developing products for the non-food industries. From its review of the Community's activities, it concluded that there were a number of important programmes supporting and inciting the processing industries to develop non-food uses of agricultural raw material but noted that there was a lack of instruments which encouraged the active participation of farmers. It concluded that, amongst other measures, the set aside scheme for arable land should be adapted to encourage the development of other new models of land use.

2.9 The Commission added that "It is evident from the foregoing review that the Community's commitment to non-food production from agriculture is already important and is seen in a wide variety of policies. It is nevertheless also evident that these policies are somewhat independent of one another. It has now become necessary to reinforce the Community's role and achieve a more effective concentration of effort".

SELECT COMMITTEE REPORT, FEBRUARY 1991

2.10 When the Select Committee on the European Communities examined non-food uses of agricultural products in February 1991, in the context of a previous round of CAP reform, it observed that "in the absence of clear commercial benefits, there are few reasons for industry to seek new sources of raw materials. Up until now hydrocarbons have been a plentiful and cheap source of energy supplies and chemicals… The consequence has been a lack of incentive in industry to diversify into the use of agricultural products… The evidence we received about the technical and economic potential of agricultural products for industrial use gives no grounds for any expectation that large new markets will soon appear" (paragraphs 94-96).

---

[4] Agriculture's contribution to gross domestic product has continued to fall and is provisionally estimated at £7.3 billion for 1998, around 1 per cent of GDP. Similarly, the workforce in agriculture, at 615,000, represents only some 2.3 per cent of the total in employment.

[5] POST, *Alternatives in Agriculture – Growing crops for industrial, energy and non-food purposes,* January 1995.

[6] COM (89) 597 final, Brussels, 23 January 1990.

2.11 When considering environmental implications, it noted that there appeared to be a common assumption that use of agricultural raw materials for industrial purposes will be environmentally beneficial but that more research was needed before industrial use of agricultural products could be put forward as a "green option". However, the report noted that "use of agricultural materials in place of hydrocarbons will certainly contribute to reductions in CO_2 and SO_2 emissions, while they may also contribute to savings in net energy use" (paragraph 103).

2.12 The European Communities Committee also expressed the view that it would be premature to develop schemes to support any large-scale expansion in the production of agricultural crops for industry, either through subsidies or through market measures. "Such schemes might merely serve to perpetuate the subsidised over-supply of agricultural commodities in the Community and create artificial distortions in the industrial sector at very high cost". Furthermore, while noting that the set aside scheme would enable farmers to obtain subsidies to grow crops for industrial purposes, rather than grow nothing at all, the Committee did not, on balance, consider that industrial set aside would be a profitable course to pursue. It "would merely transfer into the agro-industrial sector the kind of protectionist measures which most people wish to see reduced in the CAP". The Commission, in its evidence to the Committee, stated, "Reductions in support prices are precisely what is needed in order to develop new markets, non-food or food".

2.13 The European Communities Committee felt that, in the first instance, support should be restricted to research, development and demonstration projects which integrated agricultural and industrial concerns. It went on to note that "in the absence of pressing strategic arguments to the contrary, industry is understandably reluctant to invest in research, particularly into novel manufacturing or processing techniques, with such poor prospects of short-term application. But without such research, the full economic and environmental implications cannot properly be assessed, nor can a dialogue be established between the industrial and agricultural sectors over the optimum characteristics of the feedstocks required".

POST REPORT *ALTERNATIVES IN AGRICULTURE*, JANUARY 1995

2.14 In its January 1995 Report *Alternatives in Agriculture – Growing Crops for Industrial, Energy and Other Non-Food Uses*, POST noted that "interest in non-food crops has re-awakened and their potential as raw materials for industry, as energy sources, and for other uses is being evaluated in several countries". This re-awakening of interest stemmed partly from technological advances, partly from prospective environmental benefits, e.g. CO_2 reduction, but mainly from changes to the CAP and the introduction of set aside. The key issue which POST identified was whether non-food crops offered a real economic opportunity or were attractive only because of the distorting effects of CAP payments and rules.

POST NOTE 125

2.15 In March 1999, at our request, POST produced a Note which looked at developments in non-food crops since the 1995 report. This noted changes in the production of non-food crops, for example increases in linseed and oilseed rape and significant growth in flax and hemp production because of higher subsidy levels. Again the possible environmental benefits of non-food crops, particularly energy crops, were itemised and possible dis-benefits, for example increased water demand, were identified. The 1999 Note repeated the conclusion, "the overall environmental advantages compared with using more conventional materials are not self-evident".

ACTIN

2.16 The Alternative Crops Technology Interaction Network (ACTIN) is an industry-led initiative, set up in 1995, to promote the use of raw materials derived from agricultural crops as sustainable, biodegradable and CO_2 neutral replacements for petrochemical feedstocks. It encourages collaboration between researchers and the agricultural industry and, as a member of the Interactive

European Network for Industrial Crops and their Applications (IENICA), builds networking opportunities throughout Europe. Details are available on ACTIN's website: *www.actin.co.uk.*

FORESIGHT

2.17 One of the sixteen panels of the United Kingdom Government's original Foresight programme was Agriculture, Horticulture and Forestry. The panel published a report on crop production (August 1998) which dealt briefly with non-food crops. When considering market and other opportunities, it noted that changes in crops grown in the United Kingdom are driven by factors including alternative uses of crops such as industrial uses and energy.

2.18 The new Food Chain and Crops for Industry Foresight Panel has now set up six task forces to focus on the future of industrial crops. They will examine the potential of crop-based industrial products and consider the research and development needed to underpin new products and processes. The six task forces are:

- communication in the food chain;
- unlocking the potential of industrial crops;
- spreading best practice;
- food's contribution to health;
- debate on the use of technology in the food chain;
- the future skills needs of the United Kingdom's food chain and crops for industry sector.

Information about the work of the task forces will be published on the Internet in the Foresight Knowledge Pool (*www.foresight.gov.uk*)[7].

---

[7] See MAFF News Release 340/99, 7 October 1999.

CHAPTER 3: POSSIBLE APPLICATIONS AND BENEFITS

3.1 The possible industrial uses of non-food crops depend on the oils, fibres, starches and other chemicals (e.g. proteins and pigments) that each crop contains. We have received details of a wide range of end products derived from plant materials. It is not the purpose of this report to chronicle them individually, and in this section we have grouped them together under the following headings: energy crops, industrial materials (oils, starches and fibres) and speciality chemicals.

3.2 In the energy sector, the main United Kingdom focus is on electricity generation from bulk quantities of combustible plant material, although oils and starches that can be processed into liquid fuels are also of interest (MAFF QQ 4, 15, British Sugar Q 421, Shell Q 214, ADAS Q 276). As industrial materials or speciality chemicals, products derived from plants have properties, such as biodegradability and low toxicity, which can represent improvements on equivalent products derived from petrochemicals (ACTIN Q 65, Leaver Q 295, Walker Q 352). Other plants provide materials for which synthetic equivalents would be very difficult to produce (ICI QQ 526 - 528).

ENERGY CROPS

3.3 The three main ways that crops can be used as energy sources are; biomass for combustion or gasification, for heat, electricity or combined heat and power; biomass for fermentation into bioethanol fuel; and plant oils for diesel fuel. All these methods provide renewable sources of energy and reduce net emissions of CO_2 compared with the use of fossil fuels (MAFF Q 4, Powell Q 363).

Biomass for electricity generation

3.4 To stand a chance of economic viability, crops to be used as a source of energy for electricity generation need to be able to generate large volumes of high density, low moisture material from a small area of land in a short period of time. In the United Kingdom, the crops considered to be able to meet these requirements most effectively are willow and poplar short rotation coppice (SRC) (ACTIN Q 42, Biogen Q 202). Other crops being considered include the perennial grass, miscanthus (Biogen QQ 202, 209, BICAL p145). Waste straw and other by-products from arable crop production can also be used in this way (SCRI pp216, 218).

3.5 Willow SRC is a densely planted, rapidly growing crop that regenerates from the cut stumps, and can be harvested on a three year cycle. The current United Kingdom mean yield is around 7 tonnes of dry matter per hectare per year. However, plant breeding research has given rise to expectations of doubling that yield, with some test sites in Sweden producing as much as 22 tonnes of dry matter per hectare per year (Biogen Q 197). We visited Project ARBRE in North Yorkshire (visit report in Appendix 3), which will be the first power station in this country to be fuelled by SRC (augmented by forestry residue) and is aided under the United Kingdom Non-Fossil Fuels Obligation (NFFO). The electricity generating process at ARBRE will have four stages:

- Drying the chipped willow stems using waste heat.
- Gasification, where the chips thermally decompose to form a combustible gas, steam and solid carbon char. The main components of the combustible gas are CO, H_2, and CH_4.
- Gas cleaning, where any tars and impurities are removed from the gas.
- Electricity generation using a two-stage process: a 4.75 MW gas turbine and a 5.25 MW steam turbine.

3.6 Pollution from a SRC power station is expected to be low. The flue gases are likely to be cleaner than those from coal or oil-fired power stations, and the CO_2 released during combustion matches the amount absorbed during the SRC growth. The ash waste contains potash, which has value as a fertiliser. Other environmental advantages of SRC come from the ground cover which such crops provide: SRC is expected to provide a useful wildlife habitat and may support a diverse set of bird species (Kew p205, ADAS Q 289). It is also possible that SRC can be grown without intensive use of pesticides, again good for wildlife (MAFF Q 17, ARBRE p137). Fertilisers may be helpful to boost yields but, since the SRC is not destined for food use, it may be an acceptable crop to be fertilised with sewage sludge (NERC p200) thereby helping to dispose of an unwanted material.

3.7 Problems associated with SRC as a crop include its high water requirement, diseases (especially willow rust) and pests including beetles and rabbits (NERC p200, IACR p183 and Appendix 3). Rabbits are particularly troublesome when the crop is being established. Scaling up small field trials to widespread industrial production may worsen the problems from disease and some pests, but larger plantations will reduce the proportion of costs from protective fencing.

3.8 Like SRC, miscanthus provides a good habitat for wildlife. It is harvested annually with re-growth from its perennial rootstock (Biogen Q 297). Unlike willow and poplar, miscanthus is not a native United Kingdom species; it currently has few disease or pest problems (IACR p183).

3.9 Other costs associated with growing SRC or miscanthus are storage, in particular to prevent rotting between harvest and use (Bruce Q 155), and establishing the crop, especially with SRC where no significant harvest can be expected for the first four years (ETSU p160). A major consideration is the cost (financial and in terms of energy inputs) of transporting the fuel from the farms, and consequently SRC needs to be grown near to the power station (see Appendix 3). A project such as ARBRE will consume the output of up to 2,300 hectares of SRC (ARBRE p136), so good sites for biomass power stations will be those with plenty of available land nearby. Such sites are unlikely to be close to major population centres.

3.10 Existing projects, which are on only a very small scale, include SRC projects in Northern Ireland (MAFF Q 13), a 31 MW power station in Cambridgeshire that will use cereal straw for fuel, and a forest waste plant near Carlisle. Increasing the scale, and development of the technology and plant varieties, are expected to reduce the overall costs of generating electricity from biomass (MAFF QQ 10, 11, Biogen Q 179, Shell Q 233). We discuss relative costs below in Chapter 5. There are plans to develop more biomass power stations in the United Kingdom.

Bioethanol

3.11 Ethanol produced by fermentation of sugar can be used as a fuel in internal combustion engines. In certain countries (notably Brazil) where the climate is suitable for growing sugar cane, and large quantities of cheap sugar are available, bioethanol has been produced as a substitute for petrol (or to mix with petrol) to provide a renewable source of fuel for automotive transport, and as a source of hydrogen for fuel cells[8]. In the United Kingdom, sugar is produced from sugar beet, and is not currently available at a sufficiently low price to make bioethanol production viable[9]. However, we received evidence from British Sugar of a new bacterial process that can be used in place of the traditional yeast-based fermentation. The bacterial process makes use of a wider range of sugars and breaks down cellulose as well as smaller carbohydrates (QQ 421, 454). This means that the ethanol yield can be up to twice that obtained from the same biomass through fermentation with yeast.

3.12 The new process is currently being used in a plant in Louisiana USA, and British Sugar is interested in the possibility of its being applied in the United Kingdom. The bacterial process may make bioethanol a more competitive fuel here, or at least provide a way of adding value to waste agricultural products. British Sugar is also investigating the possibility of applying the bacterial process to fodder beet, in order to utilise plant capacity and the Company's expertise in handling this type of crop.

Biodiesel production

3.13 The long-chain hydrocarbon structures of plant oils give them some similar characteristics to fossil diesel fuel. Methyl ester made from oilseed rape can be used in unmodified diesel engines (ETSU p159). Biodiesel has environmental advantages over traditional diesel fuel as a result of being renewable and biodegradable, and because it burns with low emissions of sulphur compounds and particulates (ABI p112, BABFO p139).

3.14 Questions about the overall competitiveness of biodiesel are raised by its low energy output-to-input ratio (2:1 – ETSU p159), the high cost of producing biodiesel (the British Association for Biofuels and Oils provided a figure of 2 or 3 times that of fossil diesel – p139) and the limited availability of rapeseed oil at a competitive price, which stems in part from the support of rape seed for food and animal feed uses. Even so, biodiesel is better developed in some other EU countries, notably France and Germany, than in the United Kingdom.

---

[8] In our report *Towards Zero Emissions for Road Transport* of November 1996, we observed, "There are major technical and cost problems in the use of renewables for this purpose" (1st Report 1996-97, HL Paper 13, paragraph 2.62).

[9] Between 1934 and 1939, and again for a few years after 1956, there was a product available at petrol stations in Britain called Cleveland Discol – a mixture of oil-based gasoline and molasses-based alcohol for which the makers claimed several technical advantages over simple gasoline. The mixture ceased to be available when industrial alcohol ceased to be produced by fermenting imported molasses and instead was made from oil-based ethylene.

3.15 It is also technically possible to produce synthetic gasoline or diesel fuel from woody biomass. This involves gasification followed by further processing.

INDUSTRIAL MATERIALS

Oils

3.16 The oils found in plant seeds consist of fatty acid molecules whose chemical properties are dictated by the carbon chain length and the number and location of unsaturated bonds. The seeds of different species and varieties have their own range of fatty acids, making them suitable for particular applications or processing techniques. The main oilseed crops grown in the United Kingdom are linseed and oilseed rape; oils from these crops and other plant oils are also widely available on world markets. Linseed oil has many long-standing uses, including the manufacture of linoleum (hence the name of that material), putty and paint. During our inquiry, three main applications of plant oils were discussed: as lubricants, to make surfactants, and in paint formulation.

3.17 Certain plant oils can be used as lubricants without significant chemical processing. The Mobil Oil Company provided us with evaluations of rapeseed oil as a lubricant and hydraulic fluid (p196). Rapeseed oil has been examined as an alternative to mineral oil because it is biodegradable, renewable and has low toxicity. Mobil concluded that it is an excellent lubricant that can equal or surpass the performance of mineral oils in several applications. In one niche application – metal cutting – oilseed rape-based cutting oil provides a significant economic advantage to the end user. In some markets overseas, use of such products is mandatory; for example, we noted the use of low toxicity biodegradable chainsaw and engine lubricants in environmentally sensitive areas in Sweden and Austria (Walker Q 339).

3.18 The presence of an acidic chemical group and a long chain hydrocarbon in each fatty acid molecule means that plant oils can have important surface activating properties for mixtures of polar and non-polar materials (for example water and oil). Soaps and detergents for domestic use based on short-chain fatty acids (typically from palm or coconut oil) have been added to by a whole range of surfactants with uses in industrial cleaning and the agriculture, cosmetics and pharmaceutical industries (RSE p212). In principle, all classes of surfactants could be made from renewable plant materials; products from these sources tend to offer biodegradability and low toxicity (Gunstone p178).

3.19 The ability of unsaturated oils to oxidise and polymerise means that plant oils can be used as film-forming agents in paints. Reactive oils that polymerise on exposure to air or sunlight are known as drying oils. Many paints currently include volatile organic compounds (VOCs) to regulate their drying and film-forming properties; legislation limiting VOC use (see Box 6 below) has promoted interest in natural drying oils for new formulations of paint and printing ink (ACTIN Q 46). Linseed oil has been used as a drying oil in paint formulation (ICI Q 496), but other oil types (e.g. calendula oil – ADAS QQ 286, 287, p127, RSE p212) have been proposed as alternatives that have fewer drawbacks (especially less yellowing with age) than linseed. Further work in producing new varieties with optimised oil content and harvesting characteristics is required before new oils from garden plants like calendula (pot marigold) can be made available on a large scale.

3.20 The original varieties of linseed and oilseed rape were high in linoleic and oleic fatty acids respectively, but selective breeding programmes have been used to produce different varieties with oil contents tailored to different end uses. For example, Croda use a variety of oilseed rape that contains 50-60 per cent erucic acid to make erucamide, which has a market as a slip agent for polythene and in injection-moulded plastics. Erucamide is a large, relatively complex molecule and consequently attempts to produce it synthetically from petrochemicals would be very expensive (see Appendix 3).

Starches

3.21 Starch molecules are polysaccharides, made up of repeating glucose units. The physical and chemical properties of different types of starch depend on the way the polysaccharide chains branch. The industrial uses of different starches are determined by their ability to form granules or cross-links. Many UK markets for starch as an industrial non-food material are well established, but at present are almost entirely supplied by imported starches (mainly maize starch) (Royal Society p206) which have the characteristics which industry requires. The possibility of replacing imported starches with the main starch crops grown in the United Kingdom (wheat and potatoes) is being investigated (ADAS p131).

3.22 The main industrial uses for starch in the United Kingdom are in paper and cardboard manufacture, adhesives and surfactants. Areas of growing research interest include plastics and low-phosphate detergents (Royal Society p206, ADAS p131). ICI have recently been investigating the potential of starch to replace petrochemical monomers as film-forming agents in paint (ACTIN Q 46). The BBSRC highlighted (Q 128) low density packaging materials made from starch that would have the clear advantage of biodegradability over existing materials made from expanded polystyrene. ADAS provided evidence of the Oatec project, part of which involves the use of oat starch powder as a lining for latex surgical gloves (Q 237, p124). Other starches from crops such as Jerusalem artichoke and quinoa may have some specialist applications (ADAS p131), but the main opportunities in the United Kingdom appear to be for mainstream cereal starches.

Fibres

3.23 Fibres are found in the stems and leaves of plants and sometimes in the seed casings (e.g. cotton fibres). The fibres can have particular characteristics (strength, lightness, softness, water absorbency) that make them useful for industrial purposes. Flax and hemp were the two main types of plant fibre discussed during our inquiry. Both these crops are grown on a limited scale in the United Kingdom under EU support programmes. Miscanthus, as a source of useful fibres, was also mentioned (BICAL p146, RSE p213).

3.24 The useful fibres of flax and hemp are found on the outside of the plant stems, and these need to be separated from the inner, woody material before use. The process of liberating the useful fibres (retting) relies on bacteria to break down partially the bonds between the fibres and the other stem material. The quality of the fibre is determined by the retting process, and we received evidence of interest in developing more controlled ways of retting flax and hemp for more predictable fibre quality (Robin Appel Q 93, Bruce Q 155). The relict stem material from hemp retting has found a market as animal bedding (Hemcore Q 80).

3.25 Woven textiles were identified as one of the major markets for plant fibres. Linen from flax has traditionally been a high value product, but more recently flax has begun to be blended with other fibres; a market for hemp clothing has also developed[10]. The fibres can also be used for making insulation materials and geotextile matting to reduce soil erosion on slopes (Robin Appel Q 81). Many kinds of plant fibres can be used to make fibreboard and particle board.

3.26 Paper making is another area where plant fibres have applications. The strength of hemp and flax fibre means that using even small amounts can reduce the proportion of virgin fibre required to make good quality recycled paper (SCRI p218).

3.27 Composite materials made from plant fibres mixed with resin are attracting great interest as replacements for glass fibres. The plant fibres offer a better strength-to-weight ratio than glass fibre (Robin Appel Q 81), do not cause skin irritation, and can biodegrade or be burnt to recover energy (Hemcore Q 80). Internal panels for cars (in particular, in the German automobile industry) look like an interesting market for these materials.

SPECIALITY CHEMICALS

3.28 There are a large number of plant chemicals that could have some value or functionality in particular niche markets. We received evidence of a number of low volume, high value products that could be developed from plants for cosmetics, healthcare, and dyestuffs.

3.29 Specific fatty acids and essential oils are of value in cosmetics and "soft" healthcare (e.g. dietary supplements), as well as having possible uses as fine chemicals for research or small scale industrial processes. Lunaria (honesty) oil contains novonic acid which may have medical applications (see Appendix 3), borage and evening primrose both contain gamma linoleic acid, and the many uses of hemp oil in cosmetics were described in evidence from the Body Shop (Q 531).

3.30 We received evidence on woad as a source of indigo dye; a new water extraction process has been developed and a potential market in plant derived printing inks for bubblejet printers has been identified (ACTIN Q 60, Reading p228).

---

[10] Information received on visit to MAFF CSL.

The "Roofless Factory"

3.31 The evidence we received regarding speciality chemicals extended beyond the extraction of useful materials from existing plant varieties. The possibility of applying biotechnology to produce improved varieties or even to generate entirely new chemicals in plants, especially for medical applications or for the polymer industry, was often raised (Leaver Q 295, BBSRC QQ 123, 139, DuPont, Q 381). Many advantages were pointed out to us. Using plant biochemistry to produce materials for bulk or speciality markets would provide renewable sources of industrial materials. In addition, such developments could make use of the United Kingdom's knowledge base to produce complex chemicals which are currently prohibitively difficult and expensive to synthesise.

3.32 Some processes involving bacteria have already been successfully developed to produce complex new chemicals. Genetically modified bacteria are currently used to produce pharmaceuticals, but since bacteria need warmth and nutrients to grow, the fermenters in which they are nurtured need high energy inputs and constant monitoring. The end products are therefore expensive. Costs could be reduced if the same materials could be produced routinely in plants, since the energy inputs would be provided by the sun, and the processes could be conducted on a larger scale. In 1998, the first human clinical trials of vaccines derived from genetically modified plants were reported in the scientific literature. In the United States, plant biotechnology companies have already acquired farms on which to develop pharmaceutical production facilities (BBSRC p144).

3.33 Genetic modification is a technology that has caused much controversy. Although its application in crops not destined for food use may not raise the same concerns as in crops for human consumption (MAFF Q 33), others persist. As the BBSRC pointed out to us, "the environmental and ecological implications are not yet known" (p143). Some witnesses gave evidence that they were trying to avoid the use of genetically modified materials (Body Shop QQ 553–555), arguing that it would be harmful to their image among their customers (Hemcore Q 94).

3.34 However, genetic modification is not the only means of developing new products (see Box 5). The opportunities are wide-ranging. Plants already make about 100,000 chemicals (Leaver Q 295), and it is becoming increasingly possible to develop plants containing materials designed for particular end uses by using a variety of different techniques. Several witnesses highlighted the potential for conventional plant breeding programmes to bring benefits to the non-food crop sector (MAFF QQ 8, 9, BBSRC Q 129, Hemcore Q 94, Biogen Q 197). This potential, however, needed to be exploited more effectively. The intensive work to improve the yield and other qualities of food crops was contrasted with the lack of development of non-food crops (UKELA p 221).

Box 5

Selective Breeding, Genetic Modification and Non-Food Crops

For centuries, agriculture has modified the genetic constitution of plants by selective breeding. In selective plant breeding, the genes of individual plants are mixed by conventional breeding, and the resulting offspring screened for those that show desired characteristics. The chosen offspring plants are then subject to further rounds of breeding and selection until the desired characteristic is exhibited reliably and to the required degree.

Advances in biotechnology are making it increasingly routine to link certain characteristics of an organism with particular genes (i.e. specific segments of DNA) which it possesses. It is also possible to isolate individual genes and copy or alter them. Once copied or altered, the genes do not have to be put back into the organism from which they came, but can be put into a different species altogether. The term "genetic modification" refers to these methods of altering the genetic make-up of an organism. Genetic modification can be used to change certain characteristics of a plant variety or to transfer characteristics (via copied genes) from one species to another.

So far as crops are concerned, genetic modification techniques have been used to give existing crops traits that make them easier to grow (such as herbicide tolerance and resistance to insects). Varieties of soya, maize and rapeseed that have been modified in this way are the result of studies of plant genetics that took place a decade ago. Many examples are already grown commercially in the USA, while in the EU trials are under way.

The next generation of genetically modified crops is set to move away from varieties developed simply for ease of farming to ones in which the mixture of chemicals which the plants produce (e.g. fatty acids, carbohydrates and proteins) is altered. Changing the profile of the plants' chemical constituents is of interest to the food sector (to give benefits in nutrition or cooking properties) but may also have value for non-food crops. Some genetically modified varieties of this type are already available (e.g. soybeans with a reduced saturated fatty acid content) and many others are expected to be developed over the next five years or so.

Further developments could result in crops producing specific chemicals for industry that plants currently do not make at all, using sunlight as a source of energy. Developing suitable plants may however require modification of a greater number of genes than has been necessary to produce the current genetically modified crops (e.g. those with herbicide resistance), and thus may be more difficult to achieve. Current expectations are that developing the knowledge and technology required for some of these products will take at least five to ten years of research. This concept is sometimes referred to as the "roofless factory".

Genetic modification raises issues of wide public concern with respect to the potential impact on the environment, even when not directly linked to the human food chain. The need for carefully-controlled experiment and rigorous evaluation of environmental issues is another factor which must inhibit the development and acceptability of such products. However, advances in biotechnology, such as molecular marker assisted selection, also offer methods of accelerating the selective breeding process without using genetic modification (BBSRC Q 139). If the gene that produces the desired characteristic has been identified, the offspring can be screened for this gene without waiting for the plants to grow and be tested. This technique may be especially valuable for plants that take many years to develop fully (IACR p73).

CHAPTER 4: AGRICULTURAL SUPPORT PROGRAMMES

4.1 When farmers plan their enterprises, they base their decisions not only on the costs and returns from the market but also on the subsidies available and the regulatory constraints attached to those subsidies.

Current Support Measures for Food Crops

4.2 Under the Common Agricultural Policy (CAP), food and feed production in the EU is aided through a range of support mechanisms and a wide variety of programmes. The two main mechanisms are market price support, which is used to control the supply of products, and direct income support, which is provided through area payments for crops and through headage payments for livestock. Direct income support, with limits on the amount of the support imposed through quotas, was introduced as compensation for price cuts under the MacSharry reforms of 1992.

4.3 Market support mechanisms are used to raise output prices above world market levels. These tend to make production of food crops more attractive to farmers than the growing of other (non-food) crops. The mechanisms differ between commodities: there are tariffs on imports of most food products, quotas on milk and sugar beet, and intervention with export refunds for butter, skimmed milk powder, cereals and beef.

4.4 For most of the main arable crops, farmers also receive direct income support in the form of area payments. These payments, which were introduced under the Arable Area Payments Scheme (AAPS), were set in ECUs/tonne (now €/tonne). They vary according to the type of crop and regional yields[11] . The actual payments to farmers in national currency vary from year to year according to the exchange rate with the €. The 1998 payment for cereals in England was £240/ha, for oilseeds it was around £300/ha and for proteins £350/ha. The further strengthening of sterling against the € between 1998 and 1999 would normally mean that payments under the AAPS would be 13.9 per cent less in 1999 but, exceptionally, the difference is to be made up with "agri-monetary compensation".

4.5 To qualify for area payments, producers must set aside a certain proportion of their arable land (small producers are exempt up to a certain production limit)[12]. Although the set aside rate was initially at 15 per cent, it has been varied from year to year following decisions by the Council of Ministers. In 1998 it was 5 per cent and it is currently 10 per cent. Farmers must maintain their set aside land in good order but they cannot grow food crops on it and can only grow certain non-food crops. In return, they receive an annual payment, currently some £305/ha. Farmers can, under certain conditions, opt to put additional land into voluntary set aside.

4.6 The payments per head for certain types of livestock, for instance the beef special premium, are comparable to the arable area payments in providing direct income support. The support provided through these payments, and the other forms of market support for livestock production, may be viewed as indirectly supporting the pasture on which livestock graze. The result is that the growing of other crops, including non-food crops, on grassland is made less competitive.

4.7 Expenditure on market support and on direct income payments is fully funded by the EU although the United Kingdom does, of course, contribute to the EU budget and this contribution is itself subject to the Fontainebleau Abatement[13]. In addition, there is considerable expenditure on other measures to assist particular sectors of the United Kingdom agricultural industry which is either EU funded, part EU/part nationally funded or wholly national funded[14].

---

[11] The United Kingdom has five regional yields for cereals, ranging from 5.03 to 5.89 tonnes/ha.

[12] A farmer's eligible area was based under the MacSharry reforms on the area of arable land in the crop rotation in 1991. In return for the set aside payment, farmers may not grow any food crop on land that is set aside or use the land for grazing. They must also comply with strict rules for managing the land during the set aside period to ensure that it is maintained in good condition. See *Arable Area Payments*, Explanatory Guide, Parts I and II, 1997 edition and 1998 and 1999 up-dates, MAFF.

[13] The Fontainebleau Abatement is a mechanism which returns to the United Kingdom Exchequer roughly two-thirds of the difference between the United Kingdom's gross contribution to, and receipts from, the European Union budget.

[14] *Agriculture in the UK 1998*, Table 9.1.

CURRENT SUPPORT MEASURES FOR NON-FOOD CROPS

4.8 Where there is a choice, farmers will grow only non-food crops if the returns are at least comparable with those for supported food crops. This has led to the introduction in the EU of piecemeal and complex support for non-food crops.

4.9 An important example is that, subject to specific conditions, farmers can grow crops for industrial purposes on set aside land and receive the annual set aside payment (about £305/ha). The crops which qualify, and the conditions under which they may be grown, are set out in the MAFF Arable Area Payments Explanatory Guide. In the United Kingdom, the main crops grown on set aside land are industrial oilseeds and energy crops (e.g. short rotation coppice).

4.10 High erucic acid oilseed rape can also be grown on land qualifying for arable area payments and receives the same area payment as oilseeds for food or feed (about £300/ha in 1998). There is a separate area payment for linseed which amounted to nearly £470/ha in England in 1998.

4.11 For short rotation coppice (SRC), farmers in receipt of a national planting grant for biomass production can keep the same land set aside for five years in return for a payment which is guaranteed not to be reduced (in € terms) over a five year period. In addition to the set aside payment, growers of SRC can also receive a lump sum payment of £400/ha towards the cost of planting under the Woodland Grant Scheme[15]. For planting on land outside the Arable Area Payments Scheme, the amount is increased to £600/ha.

4.12 There are separate support regimes for fibre flax and hemp with a payment per hectare fixed annually. In 1998, these EU funded payments were in the range of £450-£535/ha for fibre flax and about £500/ha for hemp. Growers must have a contract with a processor and the latter is required to lodge a security with the Intervention Board Executive Agency. This security is repayable on confirmation of delivery of the crop as contracted. This measure is designed to reduce the risk of fraud through farmers receiving a payment but failing to grow and harvest a crop which meets the volume and quality criteria.

4.13 Where products of food crops, such as starch or sugar, are used for industrial purposes, refunds are paid to processors at a level designed to enable European Union suppliers to compete with imports from countries outside the European Union. The conditions relating to raw materials that could be used for both food and non-food purposes also require a contract with a processor who must lodge a security repayable only on proof that the crop has been processed for non-food use.

AGENDA 2000

4.14 Following the Commission's proposals under Agenda 2000, a number of changes to agricultural support were agreed at the Berlin European Council in March 1999. Those most relevant to non-food crops were the reduction in support prices for commodities, such as cereals, beef and milk, and the introduction of a non-crop-specific area payment. The area payments for cereals, oilseeds, linseed and set aside will be standardised by the year 2002 at 63€/tonne[16] (about £240/ha in England at 1999 exchange rates). This compares with 1998 payments in England of some £240/ha for cereals, £300/ha for oilseeds (after penalties under the Blair House Agreement), £470/ha for linseed and £305/ha for set aside. However, and contrary to the initial proposals under which the compulsory set aside rate would have been set at zero, the rate was set at 10 per cent until 2006.

4.15 A new Rural Development Regulation will change the basis on which Member States may provide support to farmers in less favoured areas, effectively replacing Hill Livestock Compensatory Allowances (HLCAs). This will require payments per head to be replaced by a payment per hectare with more explicit environmental objectives. Member States will also have discretion to reduce direct payments by up to 20 per cent according to labour force criteria, overall prosperity criteria and the total amount of direct payments received by a farm business.

---

[15] If planting is on set aside land, payments from the Woodland Grant Scheme are nationally funded. If planting is on non set aside land, the payments are 50 per cent financed by the EU, except in Objective 1 areas where there can be up to 75 per cent funding by the EU.

[16] A €9.5 supplement is paid on proteins and the durum wheat supplementary aids remain.

CHAPTER 5: ECONOMIC PROSPECTS FOR GROWING NON-FOOD CROPS

5.1 The area of non-food crops being grown in the United Kingdom is currently very small (see Chapter 2). With the over-supply of food crops in the EU and the current low prices for agricultural food products, it might be thought that non-food crops would provide an attractive option to farmers. However, non-food crops have first to overcome the barrier of support provided to food crops. In some cases this barrier has been partially removed by providing comparable support for the non-food crop. But Agenda 2000 has ruled out any support for new crops and, although such crops might well be competitive if support to all enterprises were removed, this effectively inhibits the development of these crops. In addition, the non-crop-specific payments will have a significant impact on the margins for oilseeds.

5.2 Niche markets, where the raw material requires very specific growing conditions and a high level of expertise and where the end product is of high value, provide valuable diversification for farmers on small areas of land. However, for the less specialised larger non-food crop markets, competition is likely to hold down the prices paid to farmers whose decisions will then depend significantly on the support available.

Short Rotation Coppice (SRC)

5.3 A number of witnesses (e.g. MAFF Q 4) told us that short rotation coppice (SRC) for electricity generation represents one of the more important new opportunities for non-food crops. Evidence provided by ARBRE Energy Ltd described how, under a Growing Agreement, the Company is contracted to establish a crop of SRC on condition that the grower prepares a clean seedbed and agrees to keep the crop free of weeds and to maintain fences. Under the Woodland Grant Scheme (see paragraph 4.11), £400/ha on set aside land, and £600/ha on other land, is available towards the planting of SRC. Project ARBRE growers qualify for a supplement provided by the United Kingdom Government so that a total of £1,000/ha is available on land within a 40 mile radius catchment area. Of this, the farmer retains £367/ha, and £633/ha is paid to ARBRE Energy Ltd to offset some of the establishment costs, estimated at £1,500-£2,000/ha. Under a Storage and Supply Agreement, ARBRE Energy Ltd agrees to harvest the crop and to pay the farmer £20/oven dried tonne (odt), index-linked to the Retail Prices Index.

5.4 Farmers who grow SRC on land that qualifies for arable area payments will also receive the annual set aside payment, currently some £305/ha. Assuming a yield of 10 odt/ha/year, this effectively provides growers of SRC with a gross margin of some £505/ha ((10x£20) + (£305)). This is only slightly less than average margins on wheat in 1998 and, to the extent that fixed costs such as labour, machinery and buildings (depreciation or maintenance) could be reduced over the medium term, SRC will become more attractive to farmers. Added to this, the price of SRC is index-linked over the length of the agreement and yields are likely to become more predictable and to increase as expertise in managing the crop accumulates.

5.5 Nevertheless, the current support mechanism may discourage the planting of SRC on the most suitable land. For instance, low yielding grassland in marginal areas with higher rainfall and fewer economic options may be more suitable for growing the crop (MAFF Q 7) but the area payment is only made if SRC is grown on set aside land (i.e. not grassland).

5.6 The price that electricity generators are able to pay for energy crops is clearly critical to farmers' decisions; but this price is largely determined by policies designed to meet the Government's target of 5 per cent of electricity from renewable sources by 2003 (10 per cent by 2010) and to reduce emissions of greenhouse gases under the Kyoto agreement. Under the Non Fossil Fuel Obligation (NFFO), electricity companies are required to obtain a proportion of their power from renewable sources. Generators using renewable resources compete for contracts to supply energy under NFFO orders and successful projects are awarded contracts at the bid price[17]. The difference in cost is met from the Fossil Fuel Levy of 0.3 per cent paid by consumers which raises about £40m to meet the above-market cost of projects with a NFFO contract for renewable energy.

---

[17] Under the NFFO-2 round the premium price paid to all schemes was the highest contracted price in each technology band.

5.7 In qualifying under the third NFFO round, Project ARBRE will receive about 8.65p/kWh for its electricity, compared with an average supply cost of electricity based on fossil fuel in the region of 2.5p-3p/kWh. Over a 15 year period and delivering 8MW for 8,000 hours per year, the cost of this support would be of the order of £55-£60m. In addition, a grant of some £25m was available from the EU (Thermie) towards the capital cost of the processing plant.

5.8 Even with this degree of support, it is unclear whether Project ARBRE can continue to cover its full commercial cost. With improvements in processing technology and economies of size, substantial reductions in costs are likely (Biogen Q 179, Shell Q 233), but the extent to which the very substantial gap between the full cost of this form of renewable energy and that of energy derived from fossil fuels can be bridged is uncertain. In his pre-Budget statement on 9 November, the Chancellor of the Exchequer announced that renewable energy sources will be exempt from the Government's proposed Climate Change Levy, a new tax on energy designed to reduce emissions of greenhouse gases.[18] This will enhance the viability of non-fossil fuels for electricity generation; but biomass may still fail to be competitive within this category.

5.9 Assumptions about the costs of production and yields of SRC, the prices paid, and the margins on competing farm enterprises, are critical to the analysis. A study by MAFF[19], which assumed that farmers would receive payments of £40/odt, concluded that a total subsidy to growers (including area payments) of £410m would be required over the period 1998-2024 (equivalent to a net present value (NPV) of £155m if discounted at 8 per cent) to support a total area reaching 125,000 ha in 2004. When, as part of a sensitivity analysis, a price of £30/odt was taken, the total subsidy required over the period rose to £520m (equivalent to a NPV of approximately £190m at 8 per cent)[20]. A price of £20/odt would raise the cost of support by a further £110m.

5.10 An area of SRC of 125,000 ha would be sufficient to provide some 750 MW of electricity, which is about a quarter of the energy needed to increase the proportion from renewable sources from 5 per cent to 10 per cent. This would require 20-25 of the next generation of power plants (30-40 MW each).

Fibre Crops

5.11 Under European Union policies, the area payment on flax and hemp is designed to enable these crops to compete with fibres available on world markets. The cost of these measures is high; in 1997, European Union support for the 21,000 ha of flax and hemp in the United Kingdom was over £12m (MAFF p188) and represented over 70 per cent of the total value of the output.

5.12 However, hemp and flax have received little attention from plant breeding programmes designed to increase fibre yields. Improved varieties, and more efficient processing techniques, may make the crops more competitive in the future. We received evidence of the potential of many new markets for hemp and flax products, and of the highly desirable performance characteristics of these materials (paragraphs 3.23-3.27). Nevertheless, proposals for changes to the EU regime[21] are expected which would reduce payments and could discriminate against the short fibre output that predominates in the United Kingdom. Such changes would inhibit the new technologies being introduced to meet new markets. The outcome would be margins that were insufficient to encourage the growing of fibre crops in the United Kingdom, and the existing area could decline. Reduced support and continuing uncertainty would also limit further investment in processing capacity. In the United Kingdom, there is an additional, specific disincentive for hemp in the form of a £300 licence fee which must be paid by each grower.

Oilseeds for Industrial Purposes

5.13 The current market for rapeseed for industrial use is small, which means that the crop is seldom grown without a processing contract. As long as set aside remains, and the crops which can be grown on set aside continue to be restricted, United Kingdom processors should be able to obtain adequate supplies of high erucic acid oil from domestic sources.

---

[18] Commons *Hansard* col. 889.

[19] *The Economics of Short Rotation Coppice (Willow) in the UK* by John Walsh and Tracy Brown, Government Economic Service Working Paper No.135, April 1999.

[20] *Ibid*, Annex 8.

[21] See Lords *Hansard* 23 November 1999 col. 314.

5.14 The situation may be rather different for linseed where the area payment will be halved by 2002. Unless margins for cereals and rapeseed fall substantially, the area of linseed grown in the United Kingdom is expected to decline sharply.

5.15 Overall, it is unlikely that there is significant scope for increasing the area of oilseeds grown for industrial purposes in the United Kingdom in the short or medium term and the existing area is vulnerable to policy changes which could, increasingly, put United Kingdom growers and processors at a competitive disadvantage. More importantly, the absence of a level playing field, or of any support for new crops, inhibits the growing of these crops by farmers and the development of new products.

Evidence of Demand

5.16 We have looked throughout our inquiry for evidence of industrial interest in, and demand for, products from non-food crops; and such evidence has not been hard to find. ICI told us, "At present, products based on renewable raw materials *per se* do not generally command a premium in the market and customers are demanding competitive prices and better environmental performance"; but, they added, "This may change" (p186). In oral evidence, the Technical and Operations Director of Uniqema told us that, as ICI moves from bulk to speciality chemicals, "non-food crops will become increasingly important to it" (Q 473). Following restructuring, around 25 per cent of ICI's raw materials will consist of renewable materials for non-food uses (Q 474). ICI is "interested" in exploiting plants modified by conventional breeding or biotechnology, subject to appropriate regulatory control (Q 509). The main inhibitors, according to ICI, are the cost of registering new products (Q 490) and the "rollercoaster" of supply and price created by the CAP (Q 518).

5.17 Dr Phil Taylor, a Senior Research Associate with ICI Paints, who gave evidence for ACTIN, told us that he expects land use to supply commodity chemicals to grow over the next few years, "as the consumer begins to realise this is an important area" (Q 41). "The market is there but it is under the surface...Our biggest customers in the UK, the B&Qs, the Do-It-Alls, the Homebases of this world, are very keen for us to push this work forward, because they see that as a strong selling platform...the far side of the Millennium" (Q 46).

5.18 ICI is one of the major industrial sponsors of ACTIN; another is DuPont, the United States-based global materials company. DuPont currently derives 5 per cent of its revenues from renewable raw materials; it aims to increase this to 25 per cent by 2010. It has a Cereals Innovation Centre in Cambridge (acquired in 1998 from Dalgety), researching applications of materials from major cereal crops in composite materials, medicine, crop protection, and "biorefining as a means of producing raw materials and functional products (e.g. for paints, adhesives, oil industry, detergents, cosmetics and adsorbents)" (p158). The Centre's External Affairs Manager told us that he sees "potentially a very high volume and overall high-value use" for crops replacing fossil fuels as sources of chemical feedstocks; and even greater potential value in crops as sources of completely new materials (Q 366). In his view, "If the economics became easier, there are things that could be brought to market...well within five years...We are confident that there are big opportunities...This is not a sideshow; this is a serious matter for DuPont" (QQ 368, 411, 416). DuPont is researching applications of biotechnology in this area, though in the United States of America rather than the United Kingdom (Q 381).

5.19 Mobil Oil is a leader in environmentally friendly lubricants. It sees an assured future for rapeseed oil as a cutting fluid for aluminium cutting, and good potential for it as an expensive but environmentally friendly oil for chain saws, though the biggest potential application, in hydraulic equipment, is better served by synthetics (p196).

5.20 Finally, Appendix 3 records our meeting with the Managing Directors of Croda Universal and John L Seatons, which are doing good business in high erucic acid rapeseed oil and refined linseed oil respectively.

5.21 The Chemical Industries Association told us, "Chemicals from crops offer an exciting possibility for the future success of the chemical industry" (p157). They reported increasing interest in industry, encouraged by advances in enzyme chemistry and crop technology, and by the drive towards sustainability. In their view, progress will depend on research, and on cost, which in turn depends on reform of the CAP.

CONCLUSION

5.22 It is very clear that, under current policies, non-food crops must compete for land with food crops that receive considerable support. This, combined with the reduction in area payments under Agenda 2000 and the fact that farmers can grow only certain crops on set aside land without losing set aside payments, will limit innovation in the non-food crop sector, in spite of the evident demand. The uncertainty about future CAP and national policy means that long-term investment by farmers and processors is a considerable gamble even for those non-food crops which are currently supported. This is, itself, a powerful argument for further reform of the CAP.

CHAPTER 6: PUBLIC POLICY OBJECTIVES

6.1 If a product derived from non-food crops has performance or price advantages over its competitors then it is likely to find a commercial market. Even after the recent recovery in the price of oil, there are not many applications for which agricultural products are likely to be competitive with hydrocarbon-based products on price alone. However, there are some plant-based products which have particular characteristics which may warrant their use, even if they bring no immediate commercial benefit to the user. Such characteristics may make it possible to meet environmental or sustainability policy objectives or may represent the leading edge of a major new technology. In these cases there may be sound public policy reasons why the technology should be supported. We have therefore looked at some of the policy objectives which might encourage the use of non-food crops.

ENVIRONMENT POLICIES

6.2 There is a broad group of objectives concerned with global warming and a reduction in emissions of greenhouse gases, in particular of CO_2. Many of these overlap with policies for sustainable development. In 1997, a European White Paper set the objective that 12 per cent of primary energy should come from renewable sources by 2010. The United Kingdom White Paper *Energy Sources for Power Generation* of October 1998[22] identified a central policy objective of Government to "ensure secure, diverse, and sustainable supplies of energy at competitive prices". The Government recognised that energy from renewable sources would be an important element in securing objectives relating to both diversity and sustainability.

6.3 In March 1999 DTI published a Consultation Document on renewable energy *New and Renewable Energy, Prospects for the 21st Century* which made the following points:

- the Government are committed to a strong drive to develop renewable energy;
- renewables have a key role to play in contributing to secure, diverse and sustainable energy supply;
- the Government are working towards renewable energy providing 10 per cent of electricity supplies and hope to achieve this by 2010. The Government are already on target to achieve 5 per cent of electricity from renewables by 2003;
- when renewables become competitive they will be able to take their place alongside fossil fuel sources in the open market for electricity.

6.4 The DETR Climate Change Consultation Paper of October 1998 noted that a 10 per cent contribution to electricity supplies from renewables might deliver carbon savings of 7.4 million tonnes. This represents about 25 per cent of the carbon savings needed to meet the Government's manifesto commitment. The present DTI energy projections for the United Kingdom show United Kingdom energy levels in 2010 ranging from 3 per cent below to 6 per cent above 1990 levels. It is likely that all measures listed in the DETR Consultation Paper will need to be implemented if CO_2 reductions are to be achieved.

6.5 Thus in its policies for CO_2 reduction and sustainability the Government have already set policy objectives to which non-food crops could contribute, e.g. as biomass for electricity generation. The Non-Fossil Fuel Obligation (NFFO) contributes to the achievement of these policy objectives. Generators using renewable sources compete for contracts to supply energy under the NFFO. This means that renewable sources compete with each other, with the lowest cost source winning. In many cases, this will be wind power which itself raises other environmental issues. This policy may not be effective in encouraging the development of other technologies with potential in the longer term, despite the fact that a contribution is likely to be needed from a wide range of renewable energy sources.

6.6 There are other measures for environmental protection which can have a direct impact on the market for non-food crops, for example the legislation restricting the release of volatile organic compounds (VOCs): see Box 6.

---

[22] Cm 4071.

Box 6

VOC emissions legislation

Volatile organic compounds (VOCs) are one of the key ingredients in the reactions that produce ozone in photochemical air pollution episodes. The high concentrations of ozone that can be created at ground level during such episodes have a damaging effect on the health of humans and plants. Reductions in VOC emissions from human activity (e.g. evaporated solvents and unburnt automotive fuel) have been advocated as a method of reducing photochemical ozone production.

Ozone is often formed some distance downwind of where the pollutants are released and certain meteorological conditions (especially persistent anticyclones) can result in harmful concentrations of ozone building up over a very large area. The problem, therefore, can transcend national boundaries and UK policy has recognised this.

In 1994, the United Kingdom ratified the VOC Protocol to the United Nations Economic Commission for Europe's (UNECE) Convention on Long-range Transboundary Air Pollution, which involves a commitment to reduce overall VOC emissions to 30 per cent below 1988 levels before the end of 1999. An EU Solvents Directive has also been adopted that covers industrial, but not domestic, uses of solvents that are emitted as VOCs. This means that, for example, the VOC emissions resulting from the manufacture of paint and the use of paint on industrial sites ar restricted, but emissions from DIY or trade uses of paint are not. A further EU directive is currently being prepared that is expected to cover domestic and trade uses of paint and varnish.

6.7 Legislation relating to the use of recyclable materials, particularly in packaging, can lead to considerably greater use of products derived from non-food crops. The United Kingdom legislation on packaging (see Box 7) provides no such incentive but we were told at MAFF Central Science Laboratory (see Appendix 3) that in Germany legislation provides a strong incentive to develop biodegradable material.

Box 7

Packaging waste regulations

In 1997, the Department of the Environment, Transport and the Regions introduced legislation to implement the EU Directive on Packaging and Packaging Waste. The legislation aimed to achieve a more sustainable approach to packaging waste, to reduce the amount of material going to landfill, and to make all parts of the packaging chain share the responsibility of dealing with waste.

The legislation defines packaging as "all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods". The specific targets are to ensure that, by 2001, 50-65 per cent of packaging waste (by weight) will be recovered, and that 25-45 per cent of all packaging will be recycled, with a minimum of 15 per cent for any given type of packaging material.

There is a hierarchy of preferred outcomes:

- to reduce the amount of packaging that is used;
- to re-use more packaging;
- to recycle more packaging materials.

Of the material that ends up in landfill sites, no distinction is made between long-lived materials and those which are readily biodegraded.

INNOVATION POLICIES

6.8 Quite distinct from policies relating to sustainability and the environment are those intended to encourage innovation and the development of new technology. Much evidence was presented to us relating to the potential of non-food crops for a range of applications, from low volume products, e.g. pharmaceuticals, to entirely novel ways of producing chemical feedstocks in the "roofless factory". Some of these ideas seem distant possibilities but we find it entirely plausible that advances in biotechnology could lead to significant changes in the way a whole range of products, from feedstock to speciality chemicals, is produced. Faced with the possibility of changes of such magnitude in industries where the United Kingdom has a major stake, especially in areas of research where we are amongst the world leaders, it should be a matter of public policy to evaluate and encourage the development of these technologies.

LIFE-CYCLE ASSESSMENT

6.9 Different views have been expressed as to the environmental benefits of growing non-food crops and the extent to which non-food crops contribute to the achievement of policy objectives. It is important that these views are properly considered and evaluated. We heard evidence on Life-Cycle Assessment (QQ 313 – 364) as a tool to aggregate together all the environmental effects associated with a product or process by quantifying energy and material inputs and wastes released into the environment[23]. For products derived from non-food crops, assessments can cover the entire life cycle: growing the crop, processing the raw materials, distribution and final disposal. When combined with a comprehensive cost-benefit analysis, Life-Cycle Assessments offer a way of evaluating the externalities – that is, effects which are not captured in the market price.

6.10 The technique was initially developed in a factory environment but considerable effort has gone into widening its application and to standardising the technique. Yet this work has usually concentrated on single processes, such as in the context of waste management, rather than on inter-process comparisons; and assessments have tended to relate to a particular process in a specific location. Further work will be needed in developing approaches that can take into account such aspects as biodiversity and visual amenity which are important in evaluating the overall contribution of non-food crops as sources of raw materials.

6.11 Life-Cycle Assessments of energy crops, both in the United Kingdom and in other European countries, have pointed to environmental advantages of energy crops over fossil fuels. However, the financial costs are much higher. Much further work is needed to arrive at robust valuations of the externalities which would make such techniques of greater value to decision-makers.

---

[23] A detailed description of Life-Cycle Assessment was provided by the University of Bath, p222.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 When examining earlier work on non-food crops (paragraphs 2.7-2.15), we are struck by how much has changed since the Select Committee on the European Communities considered the subject in 1991 and, at the same time, how much has remained the same. The most notable changes since 1991 are increased public awareness of environmental issues and dramatic advances in biotechnology.

7.2 There have been considerable changes in public attitudes towards the environment since 1991. There is now greater concern about the implications of increased greenhouse gas emissions. There is an acceptance of the need for sustainability in all activities. In some other European countries, this recognition has already resulted in specific action by Government. In Germany, for example, policies to encourage the use of biodegradable and sustainable products are further advanced than in the United Kingdom (paragraph 6.7). In the USA, the Government has recently issued an executive order to accelerate the development of bio-based industries as sources of energy and chemicals[24].

7.3 There is also a general recognition and acceptance of the need to protect the countryside for its own sake, and the focus of agricultural and environmental policy has shifted markedly towards this objective since 1991. The reduction of CAP price support is under way (paragraph 1.4) and removal, long talked of, is at least a possibility over the horizon.

7.4 Improvements in conventional plant breeding are likely to result in substantial increases in the yield of many of the crops which we have considered; in addition, the changes made possible by genetic modification could enable entirely new industrial processes and products to be developed (paragraphs 3.31-3.34). We recognise there are many conflicting views on genetic modification, and our inquiry has not examined these controversies. But the development of a technology resulting in the production of industrial products from renewable sources might have significant environmental and social benefits that should, at least, be weighed against the issues raised by genetic modification.

7.5 Many other things are relatively unchanged since 1991. Despite rebounding substantially this year, oil prices have not yet provided a sufficient incentive for industry to substitute non-food agricultural products for oil-based ones[25]. The assumption that the use of agricultural products for industrial purposes will automatically be environmentally beneficial has still not been rigorously tested (paragraphs 6.9-6.11). Although reform of the CAP has begun, it continues to create artificial distortions and to inhibit innovation. Policy, such as it is, for non-food crops is still largely dependent on set aside (paragraphs 4.8-13), a side-effect of the CAP cereals policy. While set aside is retained under Agenda 2000, the reduction in non-crop-specific payments will narrow margins on oilseeds, including linseed (paragraph 5.14), while further policy proposals may result in a significant reduction in the area of fibre crops grown in the United Kingdom (paragraph 5.12).

7.6 Evidence presented by a wide range of researchers and processors indicates that non-food crops show considerable potential to meet environmental policy objectives and to create new businesses. Technology is enabling new products to be developed and new applications to be found for existing ones (Chapter 3). Products derived from non-food crops can increasingly compete with synthetic products in terms of performance and have the added advantage of being biodegradable or derived from renewable resources. The recommendations which follow concern factors which support or hinder the realisation of the potential of non-food crops.

MINISTERIAL RESPONSIBILITIES

7.7 The MAFF support programme for the growing of non-food crops, which seeks to encourage "crops with a significant agricultural impact in terms of hectares" (Q 2), is too narrowly focused on this objective. We can see the attraction of crops such as short rotation coppice (SRC) to a department intent on finding productive employment for farmers. But by devoting most of its effort to this work, MAFF policy is in danger of missing the potential that new scientific developments are bringing to the non-food crop sector. Meanwhile the overlap of departmental responsibilities helps to obscure the key question: whether energy crops can ever provide a cost-effective way of generating renewable energy. MAFF's Central Research Laboratory is undertaking much good work on these new developments and some of them, for example the replacement of fossil-fuel based feedstock for the chemical industry, could eventually result in significant land use too. But the high value niche products which could eventually lead to entirely new innovative industries will certainly not do so in the short term. Yet evidence from the private sector (paragraphs 5.16–21) demonstrates the potential for important developments, which Government ought to support at this stage.

---

[24] The President's New Executive Order on Bio-based Products and Bioenergy, 12 August 1999.

[25] The most straightforward area for comparison is energy. The price of a barrel of Brent Crude was $10 in February 1999; by November it had risen to $26. According to British Biogen, speaking in May (Q 175), the cost of production of UK biomass was then $60 per tonne; at $40 per tonne, it would be competitive with oil at $10 a barrel. At the present oil price, wood is a cheaper fuel than oil. This, however, leaves out of account the capital cost of changeover. British Biogen hoped to achieve $40 per tonne in 5 – 10 years. To give another example, witnesses from DuPont's Cereals Innovation Centre told us in June that, at the oil price then prevailing, "You can forget about polymers from plants in economic terms" (Q 376).

7.8 Government responsibility for encouraging industrial innovation falls primarily on the Department of Trade and Industry (DTI), which is also responsible for renewable energy policy. But policy in this area involves also departments responsible for agriculture, the countryside, the environment, science and health; in short, a very wide spread of Government departments, made even wider by devolution. The key requirement, if there is to be "joined-up government" in this area, is that there should be a "champion" within Government pursuing an innovative approach to new industries based on non-food crops.

7.9 One mechanism for bringing together a wide spectrum of interests from industry, academia and Government is Foresight. We are encouraged to learn of the new Foresight task groups on the future of industrial crops (paragraph 2.17). This subject, which straddles many traditional divides between industry and agriculture, is ideally suited to the Foresight approach and we fully support their proposed work on the potential benefits, notably to the environment, of replacing fossil-based raw materials with crop derived products. We look forward to early results from this Foresight exercise. But however useful Foresight is, it is not a programme which leads directly to executive action by Government. What is required is a Minister within Government who can co-ordinate policy and carry programmes forward.

7.10 We have been unable to identify a co-ordinated approach across all relevant Government departments that might enable the potential of non-food crops to be realised. Some sectors, for example electricity from renewables, may be thought to have received undue attention, while there are no Government plans to nurture the diverse range of industries that could be based on non-food crops. While there is interest in particular areas or projects, there is little attempt to assess systematically the basis for future industrial applications. We have concluded that these nascent industries, which will develop from the synergy between biotechnology and the chemical industry, need to be given higher priority. Because they depend on the agricultural sector and cross many of the traditional departmental boundaries within Whitehall, **we recommend that responsibility for assessing and exploiting the potential of non-food crops, and in particular their potential to form the basis for new innovative industries, be co-ordinated by an inter-departmental committee led by the Office of Science and Technology (OST).**

7.11 **This committee should be headed by the Minister for Science as an identifiable "champion". The Minister and the committee should publish a report annually on its progress.**

7.12 The European Communities Committee, in their recent report on Electricity from Renewables[26], made a similar recommendation in the overlapping area of policy for renewable energy. They called for a "renewable energy agency with real teeth", to drive progress across the public sector towards the Government's targets; they also proposed an annual report. The Government rejected their recommendations, on the grounds of "cost and disruption", and because "energy policy covers a wide range of areas and involves a wide range of officials within government....It would be impossible for a single agency to successfully cover all of these areas"[27].

7.13 These arguments beg the very questions we pose. We do indeed seek to "disrupt" a situation which we regard as unsatisfactory; and we consider that the cost of doing so is outweighed by the opportunity cost of not doing so. It is precisely because no existing agency has the necessary remit to realise the opportunities which we have identified, that we call for a co-ordinating body. Our proposal for an inter-departmental committee is a modest one, which we hope will seize Ministers' imaginations: if it does not, we hope at least that they will be furnished with better reasons for rejecting it.

---

[26] *Electricity from Renewables*, 12th Report 1998-99, HL Paper 78, paragraphs 277 – 279 and 393.

[27] Government response to the above, October 1999 – not yet in print.

7.14 The problems we have identified with the treatment of non-food crops by the United Kingdom Government are also apparent in the European Commission (see paragraph 2.9 and Appendix 3). DG Agriculture concentrates on food production; it does not see its role as to develop new industrial sectors, even if they are based on agricultural products. Other DGs, Research, Environment and Energy, all have an interest, but we found little evidence of a co-ordinated approach on non-food crops. **We recommend that the United Kingdom Government should make representations to the European Commission to establish a coherent European policy, with emphasis on the support of a co-ordinated research programme, in the context of the 6th Framework Programme which is now under discussion. The programme should address not only new crops but also the crop handling and processing necessary for future industries.**

7.15 Although we see a need for better co-ordination within the Commission, we were impressed by the EU IENICA project and database which has been established at the MAFF Central Science Laboratory in York (paragraph 2.16 and Appendix 3). **We recommend that this database be maintained and extended to include greater technical detail to assist decision-making by growers and manufacturers.**

7.16 We can see that the ACTIN database has different objectives, is under different control, and meets different needs, but we were not convinced that there need be a separate and distinct database. An open database with full data on United Kingdom opportunities is likely to be of greater benefit than a smaller one accessible to United Kingdom members only. **We recommend that detailed consideration should be given to subsuming the ACTIN database into IENICA.**

INNOVATIVE POTENTIAL

7.17 Most commercially viable opportunities for expanding the non-food crop sector are in high value, low volume markets; essential plant oils, for example, command high prices, but are likely to remain niche market products. However, there may well be other high value, low volume markets for non-food crops that may lead to significant industries (paragraphs 3.31-3.32 and Box 1).

7.18 Many non-food crops have as yet benefited little from sophisticated plant breeding programmes. We were informed of the significant advances, especially in total yield and product quality, that could be achieved with these conventional methods (paragraph 3.34). Many witnesses indicated to us that the development of these new industries is not, therefore, entirely dependent on the use of genetic modification. However, genetic modification offers extended possibilities, especially in producing entirely new products in plants. We recognise the current concerns about the possible environmental impact of genetically modified crops; but, as we have noted throughout this report, non-food crops for industrial use may also offer significant environmental advantages. This highlights the need for carefully-controlled experimentation and evaluation, if such developments are to prove not merely scientifically possible and commercially viable but also publicly acceptable. The United Kingdom has a leading position in this field of research; and its applications for pharmaceuticals and other products may in the long term deliver benefits to the National Health Service. Whilst we are aware of the many competing claims on resources, **we strongly support the case for research into applications of biotechnology, to enable the potential for new pharmaceutical and other products to be developed from plants to be evaluated.**

7.19 The possibilities for using plant biochemistry to generate materials that could replace products synthesised from mineral oil are almost limitless. These could include commodities such as ready-made polymers, high purity fatty acids and specific starches as well as lower volume products for dyestuffs and cosmetics. **We recommend that the DTI evaluate the industrial potential of these nascent technologies, and that they be assessed on the basis of their contribution to a new biotechnology industry rather than focusing purely on ways to increase farm diversification.**

7.20 An advantage of encouraging small-scale projects for high value products are that they allow for the development of biotechnology, in which the United Kingdom is a world leader, and create a knowledge base about a wide range of novel crops. From such small projects major industries can develop. **We recommend that DTI-funded research and development is increased so that the United Kingdom will be early to market with novel industrial products from plants.**

NON-FOOD CROPS AND THE CAP

7.21 By distorting the economics of land use, the Common Agricultural Policy continues to provide a disincentive to grow new crops or develop new markets. In addition, the way the set aside regime is applied can cause non-food crops to be grown on inappropriate land (paragraph 5.5). There are unlikely to be any further significant changes in the CAP until 2006, unless possibly through further agreements on international trade with our trading partners. Nonetheless, we believe that eventually there must be a substantial reform of the CAP. **We urge the Government to use the intervening period to put in place the necessary United Kingdom research programmes to resolve the uncertainties over policy implementation and to prepare for the phased introduction of new technologies and the development of new industries.**

Energy and Environmental Issues

7.22 Some of the policy issues which affect non-food crops have been discussed in Chapter 6. In some areas there are already Government targets and statements of intent, for example with respect to greenhouse gas emissions (paragraphs 6.2-6.5) and disposal of packaging (Box 7). However, as recently reported by the Select Committee on the European Communities[28], in the important case of electricity from renewables, it is hard to see the emissions targets being met by present policies. We share the concern expressed by that Committee when it considered electricity from renewables that "renewable energy is only one facet of the policies needed to tackle the broad-ranging environmental issues facing the United Kingdom, Europe and the world. It is unacceptable that the United Kingdom cannot deliver an integrated policy in the renewables industry". **We recommend that the Government put in place as a matter of urgency more clearly defined policies to meet their environmental targets, particularly with respect to sustainability issues and the use of renewables. In doing so, they should recognise the possible contribution of non-food crops.**

7.23 So far as energy crops are concerned, Project ARBRE (paragraphs 3.5, 5.3-5.7) seemed to be a well managed demonstration project (although the low rainfall areas of Yorkshire are not the immediately obvious area for growing willow). But until there is a firmer basis on which to judge the relative merits of alternative ways of meeting the United Kingdom's sustainability policy objectives, we are not convinced that similar demonstrations need to be repeated wholesale. A clearer statement of renewable energy policy is needed, and clarity as to the real cost of energy crops, before substantial investment is undertaken. Moreover, demonstration projects must not be allowed to pre-empt funds which could otherwise be used for more fundamental research into novel uses of non-food crops. **We recommend that future proposed short rotation coppice demonstration projects for energy generation be assessed for priority by the proposed inter-departmental committee alongside alternative options for the financial support of innovative non-food crops.**

Regulatory Restraints and Drivers

7.24 We are not convinced that the overall environmental and economic impacts of different courses of action are sufficiently well understood to generate effective legislation for meeting broad policy objectives. A narrowly focused approach by each department, working on its own agenda, for example DTI and MAFF addressing separately issues relating to energy crops, is unlikely to result in the best policy overall. A more systematic approach should be adopted to evaluate the alternative approaches and in particular the net benefits of products derived from non-food crops against other renewable and non-renewable alternatives (paragraph 6.9). **We recommend that Government support further research, using techniques such as Life-Cycle Assessment, to assess the value of non-food crops in meeting their policy objectives. These assessments, with all the assumptions on which they rely, should be published.**

7.25 International examples, such as the requirement to use recyclable materials in Germany and the impact this is having on its automobile industry, show how environmentally based legislation can open up new markets for non-food crops (paragraphs 3.27, 6.7). Regulations governing the use of packaging material in the United Kingdom set a hierarchy of objectives (Box 7). The way in which this is constructed, with land-fill as something of a last resort, tends to undervalue the advantages of biodegradable packaging, of which non-food crops can provide numerous sources, over non-biodegradable material. **We urge the Government to raise the benefits of bio-degradable packaging in its hierarchy of objectives, and to recast the regulatory regime to encourage its use.**

7.26 There is a presumption against industrial development in rural areas. New industries in the countryside will create predictable planning difficulties and the handling, processing and storage of crops for industry may create others that are not easily predicted. We have not examined these issues;

---

[28] *Electricity from Renewables.*

but resolving planning problems can take time and it is essential that such problems are anticipated before they arise.

7.27 There are regulatory restraints on other aspects of these industries, and we believe that the Government should review these with a view to removing barriers to development. For example, the licensing arrangements for growing hemp for industrial purposes in the United Kingdom seem disproportionate (paragraph 5.12). They create difficulties here that growers elsewhere in Europe do not face. The slow repayment of deposits required by the EU support scheme creates further difficulties. **We recommend that the growing of industrial hemp should be deregulated.**

APPENDIX 1

MEMBERS OF SUB-COMMITTEE 1

Lord Birdwood†
Baroness Hogg (Chairman)
Lord Marlesford*
Lord Middleton*†
Lord Nathan†
Lord Porter of Luddenham
Lord Rea
Earl of Selborne*
Lord Soulsby of Swaffham Prior
Lord Walton of Detchant
Lord Williamson of Horton*

* co-opted member
† ceased to be a member of the House on 11 November 1999 in accordance with the House of Lords Act 1999.

In accordance with the Rules of the House, members declared the following interests:

Baroness Hogg
Chairman (until May 1999) of London Economics, which is a consultancy that has clients in both the pharmaceuticals and energy sectors.

Lord Marlesford
A farmer, President of the Suffolk Preservation Society and previous Chairman of the Council for the Protection of Rural England.

Lord Middleton
Director of a farming company, one of the activities of which is the production of crops for non-food uses.

Lord Nathan
Chairman of the Environment Advisory Panel of the National Grid Company plc.

Lord Porter of Luddenham
Two related interests. Chairman of the Centre for Photo-molecular Sciences at Imperial College which is concerned with photo-synthesis. Also President of the National Energy Foundation with particular interest in energy crops.

Earl of Selborne
A Director of a farming company. Trustee of John Innes Foundation and member of the John Innes Council. Trustee of the Lawes Agricultural Trust. President of the Institute of Agricultural Management. Chairman of the Agricultural Mortgage Corporation plc. Previously Chairman of the Agricultural and Food Research Council.

Lord Walton of Detchant
A peripheral interest as an occasional neuroscience adviser to a pharmaceutical company.

Lord Williamson of Horton
Previously Deputy Director General for Agriculture in the European Commission and various posts in MAFF. Non-Executive Director, Whitbread plc.

APPENDIX 2

WITNESSES

ABI (Austrian Biofuels Limited)
*ACTIN (Alternative Crops Technology Interaction Network)
*ADAS Consulting Limited
ARBRE Energy Limited
BABFO (British Association for Bio Fuels and Oils)
BASF plc
*BBSRC (Biotechnology & Biological Sciences Research Council)
BICAL (Biomass Industrial Crops Limited)
*Body Shop International plc
Dr Steve Bowra
*British Biogen
British Embassy, Washington DC
*British Sugar plc
British Sugar Technical Centre
*Dr Peter Carruthers
Chung-Wai Chiu
CIA (Chemical Industries Association)
*Department of Agriculture, Northern Ireland
*Du Pont (UK) Limited – Cereals Innovation Centre
ETSU (part of AEA Technology Environment)
European Commission (Directorate General XII)
Goreham & Bateson (Agriculture) Limited
Professor F D Gunstone
*Hemcore Limited
Horticulture Research International
IACR (Institute of Arable Crops Research)
*ICI
*John Innes Centre
*MAFF (Ministry of Agriculture, Fisheries and Food)
MAFF (Agricultural Departments & Forestry Commission)
Professor J S Marsh
Mobil Oil Company Limited
NERC (National Environment Research Council)
NFU (National Farmers' Union of England and Wales)
*Dr Jane Powell
*Robin Appel Limited
Royal Botanic Gardens, Kew
Royal Society
Royal Society of Edinburgh
SCRI (Scottish Crop Research Institute)
*Scottish Office
*Shell International Renewables
*Silsoe Research Institute
UKELA (United Kingdom Environment Law Association)
University of Bath
University of Reading
*Dr Kerr Walker

Those marked * gave oral evidence

APPENDIX 3

REPORTS ON VISITS

VISIT TO ARBRE ENERGY LIMITED, LEEDS, 27 APRIL 1999

Members present:

Lord Birdwood
Baroness Hogg (Chairman)
Lord Middleton
Lord Marlesford
Lord Nathan
Lord Rea
Lord Soulsby of Swaffham Prior
Lord Williamson of Horton

Dr John Slater, Specialist Adviser
Dr David Cope, POST

The Committee was welcomed by Dr Kevin Bond, Chief Executive, Yorkshire Water, who provided background on the ARBRE biomass (short-rotation coppice, SRC) project.

In 1994 the project obtained a NFFO contract and a grant from the EU's THERMIE programme. Technical design and planning approval commenced and was completed early in 1997. Following discussions with several banks, it was found to be difficult to provide non-recourse finance for the project. Yorkshire Water had hoped to finance it "off budget", i.e. as a separate project. Although the technology was straightforward and the individual elements were well understood, the banks were reluctant to become involved, primarily due to perceived risk in fuel supplies. Faced with this difficulty Yorkshire Water incorporated the project into its balance sheet as an internally supported project. Contracts were then signed allowing the site construction and fuel supplies to proceed.

As an aside, Dr Bond observed that assistance under the NFFO requires that a specific site be identified with deadlines placed on completion in advance of projects being started. A more flexible system based on providing capacity was needed for projects where broad objectives were set, e.g. so many megawatts to be produced from biomass. This would allow the sites to be determined later.

Dr Bond said the individual elements of the technology were well understood; it was simply a matter of sorting out the logistics of the fuel supply. Fuel transport costs led to the constraint that the coppice fuel be typically within a radius of 40 miles of the generating plant.

Doug Everard, the MD of ARBRE Energy Limited, gave a detailed presentation on the project. Yorkshire Water, as an environmental services company, will generate a third of its power from renewable sources, which include wind, landfill gas, waste to energy and ARBRE. Wind energy and biomass were the two systems they had examined in detail for future development and the company plans to develop around 350 MW of biomass projects. The first, the ARBRE biomass project, was a 10 MW unit with a capital investment of approximately £25 million. The technology to generate renewable electricity was clear: the challenge was to make the economics work.

In addition to growing willow for fuel from short-rotation coppice – which took four years from planting to first harvest, and several years to establish agreement with the necessary number of farmers – they were using forestry residue. They were building a rail link to transport this from forests, including Thetford and Keilder.

The generation cost from the NFFO contract was set at 8p per unit. This was three times that for gas but they expected improvements to bring the biomass fuel, construction and operation costs down to produce electricity at around 5-6p per unit in the next 6-7 years: there would still be a price premium for the product. However, Government policy measures in supporting energy crops would have a significant effect on reducing biomass fuel prices, leading in turn to lower energy prices.

Keith Pitcher, Director, provided more detail on SRC. The plot sizes are small, often below 10ha, but ARBRE planned to set a minimum size of 10ha in future contracts. It costs about £2,250 to establish a coppice, a significant element of which is the cost of the fencing to keep rabbits out and the supply of willow cuttings; transportation of the finished product is also significant. Larger coppices will result in lower establishment costs.

The difficulty with the EU subsidy regimes is that there is no long-term support for energy crops. Set-aside payments are only available on certain land and were subject to uncertainty, especially over the longer term. For a long-term crop which requires significant initial investment in fencing and which requires specialist machinery for planting and harvesting etc., this uncertainty is a major difficulty.

During discussion, the point was made that if the objective was to encourage the use of renewables, some mechanism had to be found to incorporate environmental costs into the price of electricity. The need for a specific policy for energy crops was also emphasised. Whilst ARBRE staff recognised the advantages of an annual crop, for example miscanthus, at present combustion technology was more suited to crops which left minimum residue, ash etc. Willow had a distinct advantage in this respect as well as being suited to local growing conditions. However, other crops including miscanthus would make a valuable contribution to fuel supplies for projects being developed in the United Kingdom.

The Committee was shown around the approximately 2ha coppice on land owned by Askham Bryan Agricultural College, near York. This was in its second year. Cuttings are planted using specially designed machinery in a cleared field free of all perennial weeds. At the end of the first year, the willow is cut back to ground level, then allowed to grow for 3 further years before it is harvested. It is then harvested on a 3 year cycle. Willow is tolerant of a broad range of conditions although it needs a slightly alkaline soil. A mix of willow varieties is planted to improve disease resistance. An incidental difficulty is that, at present, there is only one supplier of cuttings in the United Kingdom. Many parts of the process are below the critical size necessary to create competition within the industry and hence reduce costs.

When harvested, the crop is approximately 6m high. Harvested on a 3 year cycle the yield is approximately 9-12 oven-dried tons per hectare per year at first harvest, rising to 12-15 oven-dried tonnes per hectare per year in subsequent harvests.

The Committee visited the generating site under construction at Eggborough, near Selby. The site's layout and steel erection is almost complete but no equipment is installed. ARBRE hope construction will be complete "by Christmas" (1999). The process is to convert the wood chips to gas which will be used in a combined cycle plant comprising a gas turbine and steam turbine to maximise efficiency.

The incoming wood chips, after screening and drying, are gasified at around 850°C under controlled conditions to provide primarily carbon monoxide, hydrogen and methane. After cleaning the gas is compressed and injected into the gas turbine and combusted at high temperature. The output is then passed to a steam boiler to drive a steam turbine. The total output of the plant is made up of approximately 4MW from the gas turbine and 6MW from the steam turbine. Nearly 20 per cent of the power generated is used on site, including gas compression and site services, leaving 8MW to be exported to the local grid. Waste heat from the boiler is used to dry the wood chips.

During our final discussions Dr Bond emphasised that, as an environmental services organisation, Yorkshire Water had a mixed energy policy which encouraged energy efficiency and renewables. The company concentrates on onshore wind energy and biomass and plans to develop future projects as part of the Government's plans for expanding this energy sector. Yorkshire Water already achieves the equivalent of around 35 per cent of its own energy needs from renewables and is at the leading edge of its chosen technologies.

A major difficulty at present was not the technologies themselves but the wood fuel supply chain: all the elements necessary to sustain a new industry require to be put in place. Financing the biomass sector was difficult as the banks were not used to a supply chain which involved many small farmers. They were looking for a large public entity to guarantee loans, but by its very nature this was a local industry and cost reduction would flow from competition between small innovative companies, not big ones such as Yorkshire Water. Dr Bond advocated a levy on conventional power generation to support all elements of the renewable energy sector. If CO_2 targets were to be met then all renewable technologies, including wind, waste and biomass, would be needed.

VISIT TO BRUSSELS, 22 JUNE 1999

Members present:

Lord Birdwood
Baroness Hogg (Chairman)
Earl of Selborne
Lord Soulsby of Swaffham Prior
Lord Walton of Detchant
Lord Williamson of Horton

UKREP: Mr Robert Lowson, Minister (Agriculture)

The Minister provided an overview of EU agricultural policy with particular reference to non-food crops (NFC). He described an overall change in support policy from commodity pricing to area payments with more emphasis on regulatory matters. Support was within an overall financial envelope which essentially restricted new initiatives until 2006 at the earliest. There were unlikely to be any great changes in the support regime until after the WTO meeting in 2003, and then changes were more likely to be evolutionary than revolutionary. The Minister described the Commission as “talking a good game”; both the Energy and Environment Directorates had many aspirations, but if they needed money from Directorate-General VI (Agriculture) nothing was likely to come of them.

The intent of Agenda 2000 was to bring cereal prices closer to the world level and hence end the set-aside mechanism. As most interest in NFC was in growing them on set-aside land, this interest had waned, but as set aside was to remain there was now renewed interest in NFC.

Some Member States had initiatives to encourage the use of sustainable energy; for example Austria was keen to promote bio-diesel and exempted it from tax to enable it to compete with regular hydrocarbons for fuel supply. However, the majority of Member States saw NFC, particularly bio-mass, as simply a mechanism for providing jobs for farmers (except for tobacco which was a €1 billion “social policy”). Politically, the Council had an interest in renewables in general, and the United Kingdom had specifically promoted their use in electricity generation. The European Parliament had put considerable pressure on the Commission to support the development of renewables.

Fischler Cabinet: Mr John Benstead-Smith

Mr John Benstead-Smith responded to a question on whether the uncertainty over many support mechanisms, notably set-aside, and the high level of intervention in agriculture created uncertainty and stifled innovation. Were they mechanisms which inhibited farmers trying new products? He said that many Member States had different views on set-aside. For some it was simply a question of what the land could be used for, for example, growing energy crops. For others, the significance of renewable energy was such that they supported tax exemption for renewable sources and needed land to produce bio-mass. But as tax matters need unanimity, the mechanism of set-aside could meet both objectives. However, this meant that NFC were dependent on set aside policy which was determined by other demands.

Mr Benstead-Smith observed that a policy based on area payments allowed market conditions to predominate but that some Member States were nervous of significant changes in market management. There could be two reasons for a policy of interference in the market, one driven by environmental logic and the other by a “dynamic logic”, i.e. to pump-prime or support a project during the initial phases of a new activity. Member States were clearly divided about intervention in the energy market based on environmental grounds.

Mr Benstead-Smith tended to the conclusion that if greater certainty was needed it could best be achieved by each Member State basing its policy on voluntary set-aside. This would enable each Member State to tailor its renewable policy to suit its domestic needs.

Directorate-General Agriculture: Mr Lars Christian Hoelgaard

Mr Hoelgaard is responsible for the organisation of markets in crop products. He disputed the suggestion that there was discrimination against NFC. The objective of Directorate-General Agriculture was to support agricultural policy, that is the production of food. If set aside land was used for other purposes it was a side effect of that market mechanism. If there were any specific aid for NFC it would be likely to fall foul of the Blair House Agreement.

As a general rule, set aside will be around 10%; certainly it will be at a positive rate. The production of energy crops or bio-fuels was not economic unless there were other public policy objectives which could provide a fiscal incentive, for example, as part of CO_2 reduction measures. Forestry was a matter for national policy: the rural development policy allowed investment in new forestry which could cover the planting of short-rotation coppice. But the production of bio-fuels must rely on Member States paying fiscal incentives for environmental or other policy reasons for it to be economic.

There were certain areas, for example bio-degradable oils for chain saws, which would have their own market, but these were relatively small. Fibre crops (flax, hemp, cotton) were economically sustainable, and short-fibre flax and hemp were being used in the paper industry and for car interiors. Here, as in other areas, the Germans were in the lead in developing the industry.

The sugar market was delicately balanced. There were different arrangements for “A”, “B” and “C” sugar. If “A” sugar was priced at 100, “B” was priced at 65 and “C” 15 which was the world market price. The effect of allowing set aside to be used for growing sugar or fodder beet would be to increase production of “C” sugar. This would be undesirable.

Mr Hoelgard acknowledged that basing the definition of “non-arable land” on 1992 data and excluding it from set aside arrangements had the effect of excluding it from use for NFC. But he emphasised again that the purpose of set-aside was as a supply management tool for cereals. The uncertainty that resulted from changes to set aside arrangements could be overcome if NFC were restricted to voluntary set-aside. If Member States wanted to produce NFC they should not look to make it part of the agricultural policy and attempt to base it on a side effect of the cereals market management programme; they should look to rural development programmes which were decided at Member State level.

Renewable energy had progressed and there was a policy that the current level of 6% of energy from renewables on average throughout the Community should be extended to 12% by 2010. Mr Hoelgard observed that only Britain and Sweden had any significant interest in short-rotation coppice: Austria was keen on bio-gas and Germany favoured using maize for energy. German industry had also done a lot of work on using NFC in consumer products, such as washing powders and cosmetics.

The Commission’s position was quite simply that there was a policy for agriculture, there were no excess funds and it was not Directorate-General VI’s remit to deal with CO_2 effects. Any balance between environment, energy and agricultural matters was dealt with under the co-ordinating mechanisms of the Secretary General. It was not for Directorate-General VI to act independently.

Directorate-General Energy: Mr Emmanuel Xenakis

Mr Xenakis described the Commission Communication of 1997 and the subsequent White Paper which was, he said, welcomed by the Council. The objective was to double the contribution of renewables from 6% to 12% in 2010. He observed that 6% was an average throughout the Community: the United Kingdom has at present 1% electricity from renewables. The objectives were three-fold: to meet the Kyoto targets for CO_2; to develop some energy independence; and to create jobs. Bio-mass was the most important renewable and the Commission had developed plans to encourage increased use including a campaign with an official logo.

Although bio-mass was most promising, one could not generalise throughout the Community: different products suited different countries. For example, in the United Kingdom poplar and willow were important, in Greece sweet sorgum, in Finland forestry residue, and in Austria and France liquid bio-fuel from beet or cereals.

As set-aside looked likely to remain at at least 10% this should be a source of great encouragement for producers of bio-mass. Member States could support 50% of the cost of starting bio-mass crops but it was unlikely that there would be any assistance for growing such crops outside the set-aside area. Similarly, assistance for maintenance or loss of revenue from planting bio-mass crops was unlikely as it would create difficulties for those growing timber for paper production.

Directorate-General Energy: Mr Jean Francois Marchipont

Mr Marchipont is the Chief Adviser responsible for NFC. He deals with research related to energy, which in practice means the technologies for energy production, not for the bio-mass input. The Parliament has asked that 60% of the energy research budget be devoted to renewables and that of this, 75% go to demonstration projects. The bulk of the bio-mass work was demonstration projects; the problem was logistics, the collection and distribution of the bio-mass material, suggesting that bio-mass for electricity would only work at a local level. The Framework IV programme concentrated on the production of electricity but Framework V had a wider remit, allowing other uses such as transport to be included.

Of the renewable sources of energy production, wind turbines provide electricity at a cost closest to being competitive with conventional (fossil fuel) power stations. If the costs to the environment of CO_2 emissions were included in the price of conventional power, the competitive position of all renewables would improve.

Mr Marchipont said that Directorate-General XII's work started after the collection of the bio-mass product. Crop research was the responsibility of Directorate-General VI. Leaders in bio-mass research within the Community were probably Germany, France and the United Kingdom.

VISIT TO CENTRAL SCIENCE LABORATORY, MAFF; BIOLOGY DEPARTMENT, UNIVERSITY OF YORK; AND CRODA UNIVERSAL LIMITED, HULL
12/13 JULY 1999

CENTRAL SCIENCE LABORATORY, MAFF, YORK

Members present:

Lord Birdwood
Baroness Hogg (Chairman)
Lord Middleton
Lord Rea
Lord Williamson of Horton

Dr John Slater (Specialist Adviser)

The Committee was welcomed by Professor Peter Stanley, Chief Executive, who provided a brief over-view of the work of the new laboratory and set the context for the work on non-food crops (NFC). This work is undertaken in a relatively small group of the Agriculture and Environment Division and is headed by Mr Melvyn Askew.

The task of the group was to identify what industry needed, how agricultural products might meet this need and what would be their environmental impact. Very frequently industry did not know what it needed and hence it was difficult to operate a demand led programme. The Committee was then shown NFC under three broad headings: oils; fibres; and speciality products.

Oils

The Committee was shown a wide range of products which are produced from oil seeds. We looked only briefly at the high erucic oil products as we would be visiting the main producer, Croda, the following day. Some high quality German linoleum produced from linseed oil was on display. Detergent was produced from the seed of hemp, more widely known for its fibre products. A wide range of other products, biodegradable cleaning solvents from rape, surface coatings from calendula, lubricants from sunflower oil, and many applications of waxes and polishes, showed the range of products available from oil seed. Of particular interest in this and the other exhibits was the large number of products from Germany.

Fibres

Again the leading position of the Germany industry was demonstrated. Mercedes use hemp fibres to replace glass fibre for vehicle panelling. We were shown an experimental parcel shelf produced for Ford but, because of difficulties in meeting the Ford impact resistance test, it had yet to be put into production. A wide range of paper and fabric products was derived from hemp, from cigarette papers to thick absorbent matting.

In Germany the need for biodegradability, the health problems of working with glass fibre and the lighter weight of the fibre-based product were responsible for the increased use of hemp and flax.

Speciality products

An eclectic mix of plants produced a wide range of products, from woad for printing to aromatic plants for pest protection, while evening primrose and others provided extracts for the cosmetics industry. Mr Askew observed that the pharmaceutical industry frequently identified the active ingredient in any plant used as a medicine and synthesised the product.

Miss Sarah Hugo described the IENICA database (Interactive European Network for Industrial Crops and their Applications). This is a database giving applications for non-food crops. The information is plant based and enables the user to identify quickly the potential of any particular plant. The project is financed by the Research Directorate of the European Commission and run by the CSL. There is clearly some overlap with ACTIN database but the latter is different in that it identifies commercial opportunities and, for that reason, is a closed user group database. The analogous databases in other European countries, for example Germany, are open systems. As part of IENICA, CSL is preparing a report on the status of each industrial crop in each EU Member State, indicating markets, barriers and opportunities, for publication in early 2000.

Tour of glasshouses and trial fields

The Committee visited the hemp growing programme under glass. Transgenic hemp is modified so that the gene which governs the production of the psychotropic chemical THC can be switched off. This would produce a plant with zero THC, more acceptable to regulators.

The demonstration fields showed the wide range of crops grown including miscanthus and willow used as energy crops. We were told that when the energy crops were scaled up to industrial sized plantations their susceptibility to pest attack increased.

Concluding discussions

During our discussions Mr Askew was asked to identify the key inhibiting factors to the adoption of NFC. Amongst the leading factors he put a weakness in marketing of the products, a general reluctance to make any change unless it was absolutely necessary, and a general scepticism from industry of academic research. He felt that in Germany, where the use of non-food crops was much more advanced, and in Netherlands and France, industry and academia were working much more closely together. There seemed less inertia and a greater willingness to take risks. But above all in Germany there was legislation which encouraged recycling and the use of biodegradable products.

BIOLOGY DEPARTMENT, UNIVERSITY OF YORK

The Committee was welcomed by Dr Ken Dixon, Chairman of Council. The overall work of the Biology Department was described by Professor Alistair Fitter, Head of Department. He pointed out the research credentials of the University (RAE 93% at Grade 4 or higher, with the Biology Department awarded a "5"). It was a highly integrated department spanning from molecular to community biology. The funding was in excess of £20 million.

Professor Bowles described the cold stress project, undertaken as a strategic alliance with Unilever. This involved identifying plant genes encoding proteins that could bind to and prevent the growth of ice crystals. The work had discovered such an "antifreeze" protein in carrot and had confirmed the identity of its gene, by cloning it and expressing it in a model plant. Plant antifreeze proteins could have applications in frozen foods or could be used to protect against ice-damage in storage of organs for transplantation.

Three other projects were described in detail: (1) a remediation project for "brownfield" sites, when plants could be used to remove pollutants from the soil; (2) a project investigating genes that control the development of plants, in particular the extent of shoot and root branching; and (3) a project to identify the genes encoding protein glues, in particular those glues produced by marine mussels which have the ability to stick under water.

In a more general round-table discussion on the application of "functional genomics", i.e. characterising the function of genes identified in the many genome sequencing programmes world-wide, the discussion turned towards public attitudes to GM products. The staff of the plant laboratory recognised the current difficulties in perception of the relative risks and benefits of GM technology, but emphasised that it was now an essential research tool to understand living organisms. The application of the technology to crop plants was an important advance and with increasing sophistication, transgenic solutions for crop improvement and protection, as well as the use of plants as factories to manufacture non-food industrial products, could be designed to minimise the risk to the environment and the consumer.

CRODA UNIVERSAL LIMITED

Members present:

Baroness Hogg (Chairman)
Lord Middleton
Lord Rea

The Sub-Committee was met at Croda Universal by the Managing Director Keith Gregersen, and Mike Coverdale, Managing Director of John L Seatons and Co. Both companies are owned by the holding company Croda International and produce oleochemical products for industry. The Croda Universal site produces amides of fatty acids from high erucic acid rape seed oil (HERO) and tallow; Seatons produce refined linseed oil and its derivatives, mainly for use in surface coatings.

Croda International had a turnover of £355M in 1998; its oleochemicals sector (based almost entirely on animal and vegetable oils) accounts for 66 % of the turnover and 80 % of the profits. 68 % of the oleochemicals work is conducted in the United Kingdom.

Erucamide (the amide from erucic acid) is the main product of the Croda plant. It is used as a slip agent in plastics manufacture and injection moulding. Croda have about 40 % of the world erucamide market and all of their erucamide production takes place at their Hull site using United Kingdom HERO (approximately 2000 tonnes each month). Problems of changing subsidy levels and competition with other countries (notably in North America and China) were discussed. The situation is complicated by the fact that HERO is banned for food use in the EU (but is used extensively for cooking in the Far East); however it remains eligible for both set-aside and main oil seeds regime area payment subsidies in the European Union.

Following the introduction, we were shown the research laboratories on site by Dr Adam Maltby. The effects of adding even very small amounts of erucamide (as little as one part in one thousand) as a slip agent in various plastics were demonstrated. Its applications in plastic bags, bottle tops, syringes and injection-moulded plastics (where the erucamide acts like greasing a cake tin) were discussed. Dr Paul Wainwright then demonstrated Croda's facilities for testing the amide components of various plastics. The ability to offer technical support to Croda's customers was repeatedly emphasised as a major factor in maintaining Croda's dominant market share. Other research facilities were demonstrated where work is conducted on new processing techniques (a recent example had halved the batch time for making erucamide on site – effectively doubling the plant capacity) and on developing new products that build on Croda's experience of amides and plastics additives.

We were taken on a tour of the plant to show the stages of processing HERO into erucamide:

- **Splitting**, where the raw oil (as triglycerides) is reacted with water at high temperature to split the individual fatty acids from the glycerine (the latter being purified and sold separately).

- **Fractionation**, where the fatty acids are separated into an erucic acid stream and "rape top" fatty acids (essentially a waste product from this process, but with some value as a feedstock for other chemical processes). Croda have recently installed a new computer-controlled fractionating plant (at a cost of £4.5m) that provides very high purity erucic acid for amidation.

- **Amidation**, where the erucic acid is reacted with ammonia to give erucamide.

- **Finishing**, where the erucamide is formed into granules for sale.

Dave Parker, Operations Director of Croda Universal, presented us with more detail of the entire process, including the source of raw materials, in which farmers are contracted through John K Kings seed company to produce the volumes of HERO that the Croda project required. He also discussed Seatons' work with linseed oil and their worries that CAP reform might bring an end to linseed growing in the United Kingdom.

APPENDIX 4

GLOSSARY

Agenda 2000: A package of measures to reform the Common Agricultural Policy (CAP) and the EU's structural and cohesion funds. Proposals by the EU Commission in 1997 were agreed in amended form at the Berlin European Summit in March 1999.

Alternative Crops Technology Interaction Network (ACTIN): A United Kingdom industry-led initiative to promote the use of raw materials derived from agricultural crops as sustainable, biodegradable and CO_2 neutral replacements for petrochemical feedstocks.

Arable Area Payment Scheme (AAPS): EU scheme designed to reduce surplus production by requiring a proportion of arable land to be removed from production and providing an annual area payment as compensation.

Biodiesel: Diesel fuel produced from plant oils.

Bioethanol: Ethanol produced from plant sugar or starch using a fermentation process.

Biomass: Crops or waste residues which can be converted into energy by fermentation or combustion.

Blair House Agreement: An agreement whereby cumulative penalties are applied to area payments if the annual area of oilseeds grown in the EU exceeds 4.885 mil ha. The agreement is designed to protect US exports from animal feed derived from subsidised EU oilseed production.

Climate Change Levy: A proposed tax on energy use by business.

Crambe: A type of brassica which is a source of erucic acid.

Cuphea: There are many species of the Cuphea plant, which originates in Mexico and contains medium chain fatty acids similar to those in palm oil. The oils have applications in the detergent industry.

Foresight: A United Kingdom programme under which panels are set up to investigate possible future needs, opportunities and threats in different sectors, and to decide what can be done to meet the challenges.

Fontainebleau Abatement: Under an agreement with the EU, the United Kingdom receives an abatement of roughly two-thirds of the difference between its gross contribution to, and receipts from, the European Union budget.

Fossil Fuel Levy: A levy on all suppliers of electricity to enable the industry to meet the above-market costs of contracting for renewable generating capacity under NFFO orders.

Geotextile matting: Material made from natural fibres used to prevent soil erosion.

Hill Livestock Compensatory Allowances: A United Kingdom funded scheme which provides aid for the production of cattle and sheep in hill areas.

Interactive European Network for Industrial Crops (IENICA): An EU funded collaborative networking system to link key individuals from industry, government and science in order to identify opportunities for industrial crops or applications.

Life-Cycle Assessment: A research technique designed to measure all the inputs and outputs of a process from production to final use.

MacSharry reforms: A package of measures, introduced in 1992 by the then EU Agricultural Commissioner, Ray MacSharry, aimed at reducing the costs of the CAP.

Non crop specific payment: Introduced under Agenda 2000 to provide the same annual area payment for cereals, oilseeds and set-aside.

Non-food crops: Crops grown for industrial purposes, other than for food.

Non Fossil Fuels Obligation (NFFO): Government programme which currently requires the electricity industry to contract for specified amounts of renewable generating capacity from renewable sources.

Oatec Project: Research project into new markets for oats funded by the Home Grown Cereals Authority.

Project ARBRE: Project set up by Yorkshire Water to develop a renewable, sustainable and efficient energy source based on short rotation coppice and forestry residue material.

Quinoa: An annual plant cultivated in South America for its farinaceous seeds.

"Roofless factory": The concept of using plant biochemistry, with sunlight as an energy source, to produce bulk chemicals.

Set-aside: Land on which farmers may not grow food crops under the AAPS and may only, under specific conditions, grow certain non-food crops.

Short Rotation Coppice (SRC) willow: Willow which can be used for energy generation and regenerates quickly after cutting.

Stokes aster: Contains long chain fatty acids, particularly vernolic acid, which has applications in the plastics, paints and adhesives industries.

Surfactant: A substance, such as a detergent, that reduces the surface tension of a liquid, allowing it to foam or to be absorbed by solids (a wetting agent). The term surfactant is a contraction of "surface-active agent".

Volatile organic compounds (VOCs): Small molecules, typically composed of short-chain hydrocarbons, that exist largely in the gas phase at ambient temperatures. Reactions of VOCs in polluted air can produce harmful gases such as ozone.

Printed in the United Kingdom by The Stationery Office Limited
12/99 470513 19585 CRC Supplied.

ISBN 0-10-400500-9

9 780104 005002

Published by The Stationery Office Limited
and available from:

The Publications Centre
(Mail, telephone and fax orders only)
PO Box 276, London SW8 5DT
General enquiries *Lo-call* 0845 7 585463
Order through the Parliamentary Hotline *Lo-call* 0845 7 023474
Fax orders 0870 600 5533
Email orders book.orders@theso.co.uk

The Stationery Office Bookshops
123 Kingsway, London WC2B 6PQ
020 7242 6393 Fax 020 7242 6394
68–69 Bull Street, Birmingham B4 6AD
0121 236 9696 Fax 0121 236 9699
33 Wine Street, Bristol BS1 2BQ
0117 9264306 Fax 0117 9294515
9–21 Princess Street, Manchester M60 8AS
0161 834 7201 Fax 0161 833 0634
16 Arthur Street, Belfast BT1 4GD
028 9023 8451 Fax 028 9023 5401
The Stationery Office Oriel Bookshop
18–19 High Street, Cardiff CF1 2BZ
029 2039 5548 Fax 029 2038 4347
71 Lothian Road, Edinburgh EH3 9AZ
0870 606 5566 Fax 0870 606 5588

The Parliamentary Bookshop
12 Bridge Street, Parliament Square
London SW1A 2JX
Telephone orders 020 7219 3890
General enquiries 020 7219 3890
Fax orders 020 7219 3866

Accredited Agents
(see Yellow Pages)

and through good booksellers

© Parliamentary Copyright House of Lords 1999
Applications for reproduction should be made in writing to the Copyright Unit,
Her Majesty's Stationery Office, St Clements House, 2–16 Colegate, Norwich NR3 1BQ
– Fax 01603 723000

ISBN 0 10 400500 9